

RADIO'S GREATEST MAGAZINE

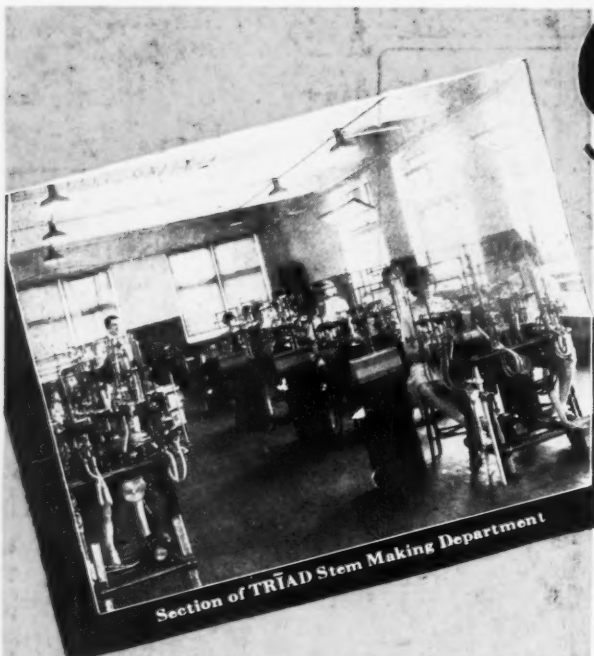
RADIO NEWS

REG. U.S. PAT. OFF.

OCTOBER
25 CENTS



Complete List of Broadcast and Short-
Wave Broadcast Stations of the World



Section of TRIAD Stem Making Department



Section of TRIAD Testing Department



TRIAD Packing Dept.



Final Tests ... to assure perfection

Naturally — every TRIAD Tube is constantly, rigorously tested throughout the entire manufacturing process — a special test follows every individual operation. Yet TRIAD does *more than that!* When completed, each TRIAD Tube is subjected to nine *additional* and *final* tests for vital characteristics — tests so stringent that nothing short of absolute perfection can survive them! This infinite care in manufacture has won for TRIADS their reputation for superior quality — and has made possible that guarantee that goes with every TRIAD Tube — a minimum of six months' satisfactory service or a proper adjustment. You can rely on TRIADS — the tubes backed by an actual Insurance Certificate!

*Call your jobber or write us direct
for complete TRIAD information.*

TRIAD MFG. CO., Inc., Pawtucket, R. I.

Tune in on the TRIADORS every FRIDAY evening, 8 to 8:30 Eastern Daylight Time, over WJZ and associated NBC Stations.

TRIAD

INSURED

RADIO TUBES

Ask for the tube in the black and yellow triangular box.



FINAL TESTS

Below are listed the nine *final* tests for vital characteristics to which every TRIAD Tube is subjected.

- 1 Gas
- 2 Emission
- 3 Filament Current
- 4 Plate Current
- 5 Oscillation
- 6 Grid Voltage
- 7 Mutual Conductance
- 8 Plate Impedance
- 9 Amplification Constant

4 of the 40 Easy Ways to Make \$3⁰⁰ an Hour

THE four plans shown are but a sample of the many ways in which our members are making \$3.00 an hour upwards, spare time and full time, *from the day they join the Association.* If you want to get into Radio, have a business of your own, make \$50 to \$75 weekly in your spare time, investigate the opportunities offered the inexperienced, ambitious man by the Association.

Our Members Earning Thousands of Dollars Every Week

The Association assists men to cash in on Radio. It makes past experience unnecessary. As a member of the Association you are trained in a quick, easy, practical way to install, service, repair, build and rebuild sets—given sure-fire money-making plans developed by us—helped to secure a position by our Employment Department. You earn while you learn, while you prepare yourself for a big-pay Radio position.

The Association will enable you to buy parts at wholesale, start in business without capital, help you get your share of the \$600,000,000 spent annually for Radio. As a result of the Association, men all over the country are opening stores, increasing their pay, passing licensed operator examinations, landing big-pay positions with Radio makers.



Mail Coupon Today for the FREE HANDBOOK

It is not only chock-full of absorbing information about Radio, but it shows you how easily you can increase your income in your spare time. Mailing the coupon can mean \$50 to \$75 a week more for you.

Radio Training Association of America
4513 Ravenswood Avenue Dept. RN-10, Chicago, Illinois

In Your Spare Time in RADIO



Below are a few of the reports from those now cashing in on the "40 Easy Ways"

Clears \$3,000.00 Frank J. Deutch, Pa. — "Since joining the Association I have cleared nearly \$2,000.00. It is almost impossible for a young fellow to fail, no matter how little education he has, if he will follow your easy ways of making money."

\$1,100.00 in 6 Weeks J. R. Allen, Calif. — "Have done over \$1,100.00 worth of business in the last 6 weeks. Next month I am going to open up a store of my own. I never knew that money could come so fast and easy."

\$25.00 a Week Spare Time N. J. Friedrich, N. Y. — "I have averaged \$25.00 a week for the last 7 months even though I am not a graduate but just learning."

Training Lands Him Job R. C. Kirk, N. C. — "Your training has been very valuable to me. I landed a job with the big department store out here a few weeks ago because I had my membership card with me. There were a large bunch of applications ahead of me."

ACT NOW If You Wish NO-COST Membership

For a limited time we will give to the ambitious man a No-Cost Membership which need not—should not—cost you a cent. For the sake of making more money now, and having a better position in the future, mail coupon below *now*. You'll always be glad you did.

Radio Training Association of America
Dept. RN-10, 4513 Ravenswood Ave., Chicago, Ill.

Gentlemen: Please send me by return mail full details of your Special No-Cost Membership Plan, and also a copy of your Radio Handbook.

Name _____

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Radio News

Volume XI.

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Technical Editor

ARTHUR H. LYNCH, Editorial Director
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Managing Editor

EDWARD W. WILBY
Associate Editor

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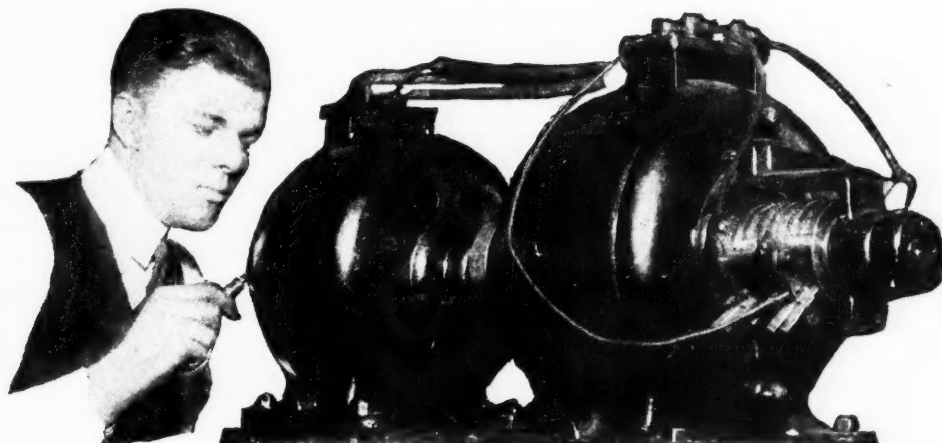
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EDWARD LANGER PRINTING CO., INC., JAMAICA, N. Y.



Amazingly Easy Way to get into ELECTRICITY

Don't spend your life waiting for \$5.00 raises in a dull, hopeless job. Now . . . and forever . . . say good-bye to 25 and 35 dollars a week. Let me show you how to qualify for jobs leading to salaries of \$50, \$60 and up, a week, in Electricity—NOT by correspondence, but by an amazing way to teach, that makes you a practical expert in 90 days! Getting into Electricity is far easier than you imagine! Act now, today!

Learn Without Books in 90 DAYS

LACK of experience—age or advanced education bar no one. I don't care if you don't know an armature from an air brake—I don't expect you to! I don't care if you're 16 years old or 40—it makes no difference! Don't let lack of money stop you. Most of the men at Coyne have no more money than you have.

Railroad Fare Allowed

I will allow your railroad fare to Chicago, and if you should need part-time work I'll assist you to it. Then, in 12 brief weeks, in the great roaring shops of Coyne, I train you as you never dreamed you could be trained . . . on the greatest outlay of electrical apparatus ever assembled . . . costing hundreds of thousands of dollars . . . real dynamos, engines, power plants, autos, switchboards, transmitting stations . . . everything from doorbells to farm power and lighting . . . full-sized . . . in full operation every day!

No Books—All Actual Work

No books, no baffling charts . . . all



Prepare for Jobs Like These

Here are a few of hundreds of positions open to COYNE-trained men. Our free employment bureau gives you lifetime employment service.

Armature Expert	up to \$100 a Week
Substation Operator	up to \$65 a Week
Auto Electrician	\$60 a Week and up
Inventor	Unlimited
Maintenance Engineer	up to \$100 a Week
Service Station Owner	\$80 a Week and up
Radio Expert	\$60 a Week and up

Clyde F. Hart got a position as electrician with the Great Western Railroad at over \$100 a week. That's not unusual. We can point to Coyne men making up to \$600 a month. \$60 a week is only the beginning of your opportunity. You go into radio, battery or automotive electrical business for yourself and make up to \$15,000 a year.

real actual work . . . building real batteries . . . winding real armatures, operating real motors, dynamos and generators, wiring houses, etc., etc. That's a glimpse of how we make you a master practical electrician in 90 days, teaching you far more than the average ordinary electrician ever knows and fitting you to step into jobs leading to big pay immediately after graduation. Here, in this world-famous *Parent school*—and nowhere else in the world—can you get such training!

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Don't worry about a job, Coyne training settles the job question for life. Demand for Coyne men often exceeds the supply. Our employment bureau gives you lifetime service. Two weeks after graduation,

AVIATION ELECTRICITY



Students wiring and checking ignition on one of the late type Radial Aircraft Engines in our aviation department.

I am including my new Aviation Electricity course as well as Radio and Automobile Electrical courses to all who enroll now.

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Coyne is your one great chance to get into electricity. Every obstacle is removed. This school is 30 years old—Coyne training is tested—proven beyond all doubt—endorsed by many large electrical concerns. You can find out everything absolutely free. Simply mail the coupon and let me send you the big, free Coyne book of 150 photographs . . . facts . . . jobs . . . salaries . . . opportunities. Tells you how many earn expenses while training and how we assist our graduates in the field. This does not obligate you. So act at once. Just mail coupon.

Get this FREE Book



Mr. H. C. LEWIS, Pres.
COYNE ELECTRICAL SCHOOL Dept. 79-27
500 S. Paulina St., Chicago, Ill.

Dear Mr. Lewis: Without obligation send me your big free catalog and all details of Railroad Fare to Chicago, Free Employment Service, Aviation Electricity and Automotive Electrical Courses and how I can "earn while learning."

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City..... State.....

COYNE
500 South Paulina Street

ELECTRICAL SCHOOL
H. C. LEWIS, Pres. Established 1899
Dept. 79-27, Chicago, Illinois



© Underwood & Underwood

Bringing *the Mountain* to Mahomet

HERE is Floyd Gibbons, well-known writer, with a portable short-wave transmitter, giving a running account of events in connection with the arrival of the *Graf*

Zeppelin at Lakehurst, August 4; his voice being picked up and rebroadcast over a nation-wide hook-up. Two men, with ten-foot poles, carried his antenna system.

FREE!



I Give You 6 Big Outfits of Radio Parts

With them you can build 100 different circuits—learn the "how" and "why" of practically every type of Radio set made. This kind of training fits you to step into the good jobs—sends you out an experienced Radio expert. When you complete, my Employment Department will help you to get a real big Radio job like Graduate Edward Stanko, now chief operator of Station WGR, or Frank M. Jones, 922 Guadalupe St., San Angelo, Texas, builder and operator of Station KGFI and manager of the best equipped Radio shop in the southwest, or help you start a Radio business of your own like Richard Butler, 1419 N. 17th St., Philadelphia, Pa., who made around \$500 a month compared with a small salaried, no future job as a motorman when he enrolled.

My Radio Training is the Famous "Course That Pays for Itself"

Spare time earnings are easy in Radio almost from the time you enroll. G. W. Page, 1807 21st Ave. S., Nashville, Tenn., made \$935 in his spare time while taking this course. Al Johnson, 1409 Shelby St., Sandusky, Ohio, \$1,000 in four months, and he didn't know the difference between a condenser and a transformer when he enrolled. I'll give you a legal contract, backed by N. R. I., pioneer and largest home-study Radio school in the world, to refund every penny of your money if you are not satisfied, upon completing, with the lessons and instructions received. Find out what Radio offers you—get the facts. Mail coupon—RIGHT NOW.

MEN! Here's the 'dope' you've been looking for

HOW TO GET INTO THE RADIO BUSINESS-

J.E.S.

If you're earning a penny less than \$50 a week, clip coupon now for FREE BOOK! New 64-page book pictures and tells all about the Radio business, hundreds of opportunities—in work that is almost romance! YOU can learn quickly and easily at home, through my tested, proved methods, to take advantage of these great opportunities! Why go along at \$25, \$35, or \$45 a week when you can pleasantly and in a short time learn how to hold the big-pay job?

Clip Coupon for Free Book

Don't envy the other fellow who's pulling down the big cash! My proven home-study training methods make it possible for you, too, to get ready for better jobs, to earn enough money so you can enjoy the good things of life. One of the most valuable books ever written on Radio tells how—interesting facts about this great field, and how I can prepare you in your spare time at home to step into a big-pay Radio job. **GET THIS BOOK. SEND COUPON TODAY.**



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Dept. 9XTT
Washington, D. C.

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Dear Mr. Smith:
Without obligating me
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information about your practical
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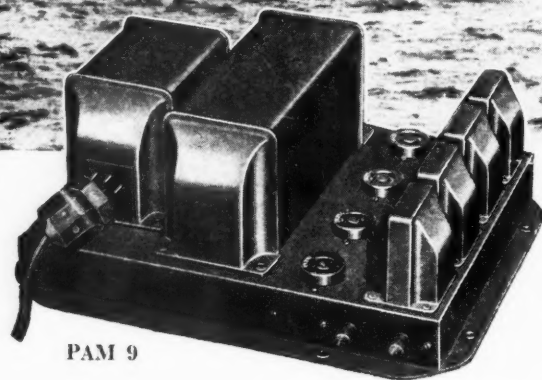
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U. S. S. WYOMING, PAM EQUIPPED



P A M



PAM 9

Accompanies the Big Guns

Where important events are staged, in this and many other countries, you will find Samson PAM Amplifiers providing entertainment and instruction through loud-speaker systems.

Not only on battleships, but on coast-wise vessels and excursion steamers—probably in your neighborhood—are opportunities for such installations.

Truly these are opportunities for worth-while profits from the sale of

PAMS and associated equipment, such as radio sets and loud speakers, phonographs and pick-ups, microphones and wiring.

A new 16-page bulletin giving mechanical and electrical characteristics, representative installations, and many new PAM Amplifiers will be sent upon receipt of 10c in stamps to cover postage. When writing ask for Bulletin No. RN3.

Main Office:
Canton, Mass.

Samson Electric Co.

MEMBER
RMA

Manufacturers Since 1882

Factories at Canton
and Watertown, Mass.

▶▶▶

With EVEREADY RAYTHEON 4-PILLAR Tubes, you can get the MOST from your present radio receiver

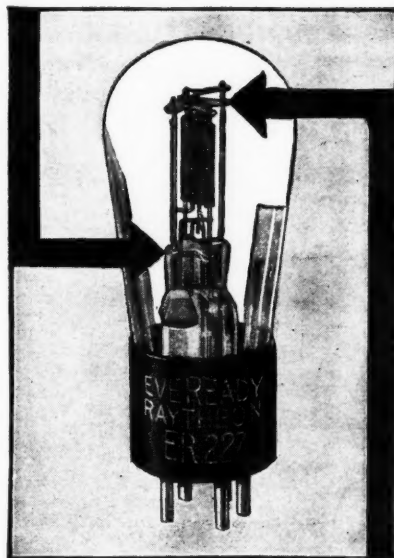
PEOPLE in all parts of the country are telling of the greater power, increased distance, improved tone, and quick action of these remarkable new tubes. The reason is that

Eveready Raytheons are built stronger—immune to the bumps and jolts of shipment and handling. They come to you in as perfect condition as when they leave our laboratory test room.

types. At your dealer's. He also has the famous B-H tube for "B" eliminator units.

NATIONAL CARBON CO., INC.
General Offices: New York, N. Y.

Unit of **UCC** and Carbon Corporation
Union Carbide



Showing the exclusive, patented Eveready Raytheon 4-Pillar construction. Note the sturdy four-cornered glass stem, the four heavy wire supports, and the bracing by a stiff mica sheet at the top.

The Eveready Raytheon 4-Pillar construction is exclusive and patented. Examine the illustration at the bottom of this page. See how the elements of this tube are anchored at eight points.

This is of particular importance in tubes of the 280 rectifier and 224 screen-grid type which have heavier elements, and in tubes used for push-pull audio amplification, where uniform characteristics are most essential. Eveready Raytheon 4-Pillar Tubes come in all



Eveready Raytheon Screen-Grid Tube. ER 224. Without Eveready Raytheon's 4-Pillar construction, this type of tube is delicate, liable to severe damage in shipment.



Trade-marks

4 SCREEN-GRID TUBES AND POWER-DETECTION!

Screen-Grid Performance

Screen-Grid Tubes have opened the door to an altogether new kind of distance-performance in Radio. The new NATIONAL MB-29 Screen Grid Tuner uses 4 A. C. Screen-Grid tubes.

Why Power Detection?

The latest and biggest improvement in Broadcasting is the use of High-Percentage-Modulation, now employed by the newest and finest stations. Soon all stations of any importance will adopt it, because of the better transmission it permits.

This improvement is not particularly noticeable with receivers using the older forms of detection. But we have just developed a system of Power-Detection especially designed to secure proper reception from stations using High Percentage Modulation and this is now offered for the first time, in the MB-29.

Band-Selector Tuning

Band-selector tuning assures sharp separation between stations, and, at the same time, finest quality of reproduction, because with the "open window" of the tuning curve, side-bands are not cut.

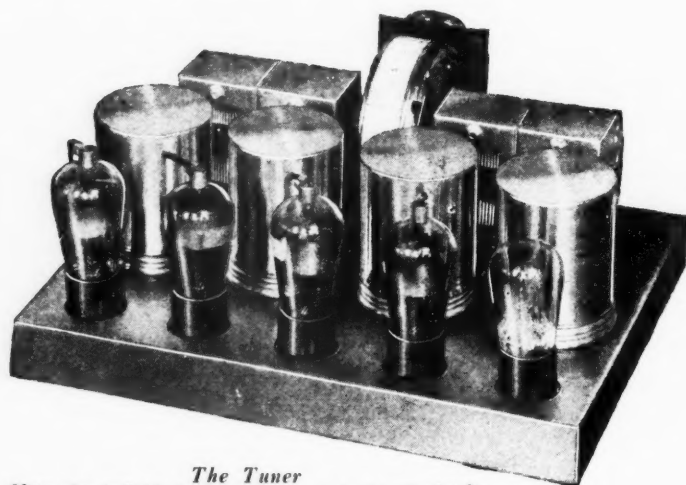
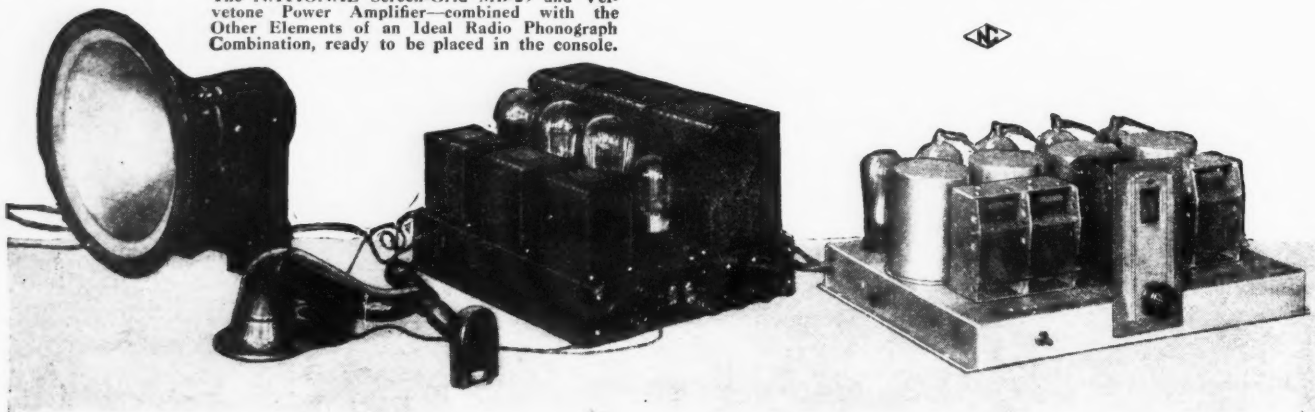
A Magnificent Chassis

With its completely shielded aluminum chassis, precision matched coils and latest NATIONAL Weld-Built Condensers—with its modernist NATIONAL Projector Dial—this tuner makes possible the construction of a magnificent A. C. receiver which combines the cleancut finish and appearance of the finest factory-built model with the quality and perfection of a custom-built job.

The Velvetone Amplifier Power Supply

For use with the MB-29 Tuner is the specially designed NATIONAL Velvetone Amplifier, a complete Amplifier-Power Supply, using two UX245's in push-pull and

The NATIONAL Screen-Grid MB-29 and Velvetone Power Amplifier—combined with the Other Elements of an Ideal Radio Phonograph Combination, ready to be placed in the console.



The Tuner
Note the individual Coil Shields and the absolutely cleancut appearance.

equipped with phonograph jack. This amplifier is licensed under patents of R. C. A. and Associated Companies and is sold fully wired and ready for use (less tubes).

Consoles and Tables for the MB-29

There are available a selection of beautifully finished and specially priced consoles and tables for housing the MB-29 in various popular combinations.

The MB-29 bristles with new and ingenious features for your convenience and pleasure. Write us today for full information, mentioning *Radio News*.

NATIONAL COMPANY, INC.
ENGINEERS & MANUFACTURERS
61 SHERMAN ST., MALDEN, MASS.
EST. 1914 . W. A. READY, PRES.

NATIONAL
« SCREEN-GRID » --
Ask Us About It. Write Us Today.

MB-29

SM

New S-M Custom Receiver Designs Shatter All Records

Single Control

Perfect convenience in operation, with a tremendous gain in selectivity and sensitivity—that's what has been accomplished in the new S-M receivers. Newly developed shielded coils make possible, with straight single control, a degree of selectivity never before achieved, even with multiple controls or verniers. One tuning control, one volume control, an on-off switch—that's all. All these receivers have push-pull 245 output stages, and both broadcast receivers embody the latest band-selector tuning.

All-A. C. Operation

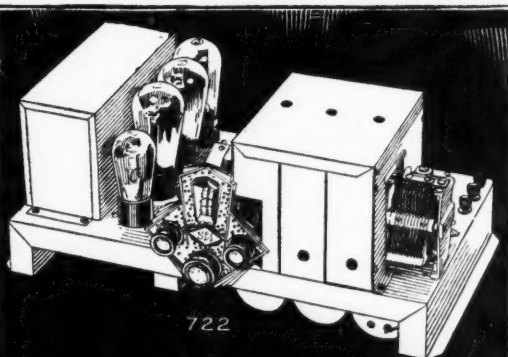
These receivers are absolutely all-electric—even the 735 short-wave set, the first of its kind ever offered on the market. Power supplies are built into the receivers—not separate. The full advantages of the new a. c. screen-grid tubes are secured. The characteristic superior S-M tone quality, distance-range, and selectivity are in these receivers as never before, due not alone to band-selector tuning but also to still greater refinements of design and accuracy of manufacture.

S-M Speakers and Power Amplifiers

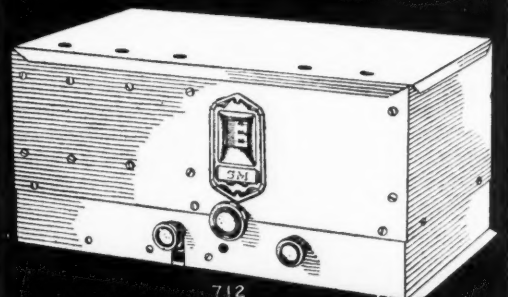
Nothing more beautiful in sound reproduction has ever been heard than the new S-M dynamic speakers, when supplied from a powerful S-M push-pull audio amplifier—giving straight-line amplification from 5000 cycles down even to below 50. These new medium-voltage high-power two-stage amplifiers, using 245 tubes in push-pull are built into the 722 and 735, and an extra high-grade Clough-system amplifier is obtainable separately, as the 677.

Beautiful Cabinets

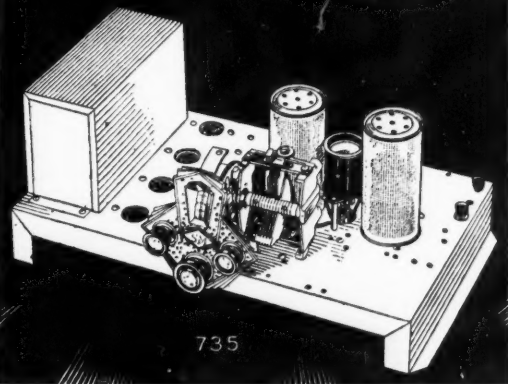
The handsome new 707 table model shielding cabinet, finished in rich crystalline brown and gold, suitable for 722, 735, or 735DC, is only \$7.75. Special arrangements have been made whereby these receivers may be housed in magnificent consoles especially adapted to them. Be sure to send for the new Fall S-M General Parts Catalog, for details of these cabinets.



722



712



735

722 Band Selector Seven

Providing practically all 1930 features found in most new \$200 receivers, the S-M 722 is priced absurdly low in comparison. 3 screen-grid tubes (including detector), band-filter, 245 push-pull stage—these help make the 722 the outstanding buy of the year at \$74.75 net, completely wired, less tubes and cabinet. Component parts total \$52.90. Tubes required: 3—'24, 1—'27, 2—'45, 1—'80.

712 Tuner

Far more selective and sensitive even than the Sargent-Raymont 710, the new single-control 712 with band-filter and power detector stands far beyond competition regardless of price. Feeds perfectly into any audio amplifier. Tubes required: 3—'24, 1—'27. Price, only \$64.90, less tubes, in shielding cabinet. Component parts total \$40.90.

677 Amplifier

Superb push-pull amplification is here available for only \$58.50, less tubes. Ideal for the 712. Tubes required: 2—'45, 1—'27, 1—'80. Component parts total \$43.40.

735 Short-Wave Receiver

A screen-grid r. f. stage, new plug-in coils covering the bands from 17 to 204 meters, regenerative detector, a typical S-M audio amplifier, all help to make this first a. c. short-wave set first also in performance. Price, wired complete with built-in power unit, less cabinet and tubes, only \$64.90. Component parts total \$44.90. Tubes required: 1—'24, 2—'27, 2—'45, 1—'80. Two extra coils, 131P and 131Q, cover the broadcast band at an extra cost of \$1.65.

Adapted for battery use (735DC) price, \$44.80, less cabinet and tubes. Component parts total \$26.80. Tubes required: 1—'22, 4—'12A.

Did You Get the Red-Hot News in the July RADIOBUILDER?

Keep up-to-date on Silver-Marshall progress; don't be without THE RADIOBUILDER. New products appear in it in advance of public announcements—all of the receivers and cabinets above were described in detail and illustrated in THE RADIOBUILDER for July. Many hints on operating and building appear in it. Use the coupon.

It Looks Like a Big Year For S-M Service Stations

Custom-builders using S-M parts have profited tremendously through the Authorized S-M Service Station franchises. Silver-Marshall works hand-in-glove with the more than 3000 professional and semi-professional builders who display this famous insignia. If you build professionally, let us tell you all about it—write at once!

SILVER-MARSHALL, Inc.

6405 West 65th St., Chicago, U. S. A.

Silver-Marshall, Inc.
6405 West 65th Street, Chicago, U. S. A.

...Please send me, free, the new Fall S-M Catalog; also sample copy of The Radiobuilder.

For enclosed in stamps, send me the following:

..... \$1.00 Next 12 issues of The Radiobuilder

..... \$1.00 Next 25 issues of The Radiobuilder

S-M DATA SHEETS as follows, at 2c each:

- No. 3. 730, 731, 732 Short-Wave Sets
- No. 4. 255, 256, etc., Audio Transformers
- No. 5. 720 Screen Grid Six Receiver
- No. 6. 740 "Coast-to-Coast" Screen Grid Four
- No. 7. 675ABC High-Voltage Power Supply
- No. 8. 710 Sargent-Raymont Seven
- No. 9. 678PD Phonograph-Radio Amplifier
- No. 10. 720AC All-Electric Screen-Grid Six
- No. 12. 669 Power Unit (for 720AC)
- No. 14. 722 Band-Selector Seven
- No. 15. 735 Round-the-World Six
- No. 16. 712 Tuner (Development from the Sargent-Raymont)
- No. 17. 677 Power Amplifier for use with 712

Name

Address

New Handibooks for Every Home

Get Them

From Your Newsdealer

or Fill Out and Mail Coupon Below



RADIO TROUBLE FINDER 1930 Edition

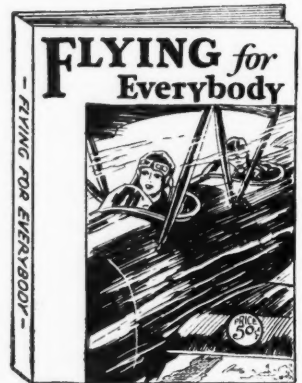
Ever have your radio fail when a big program was on? That's when the New Radio Trouble Finder is worth its weight in gold! It tells you what to do, and do quickly in order to find and repair the trouble. 64 pages in easy-to-understand language and non-technical diagrams. Every home should own a copy. Price postpaid only

25c

FLYING FOR EVERYBODY

Everyone interested in aviation should own this most helpful book. Includes the fundamental principles of flying; how to learn to fly; how to tell when a plane is safe; passenger rates on newest air routes, etc. In fact, it might well be called a complete encyclopedia on Aviation. 96 pages, fully illustrated. Printed in the large 9 by 12 inch size, with beautiful colored cover. Price postpaid only

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RADIO AMATEUR'S HANDBOOK 1930 Edition

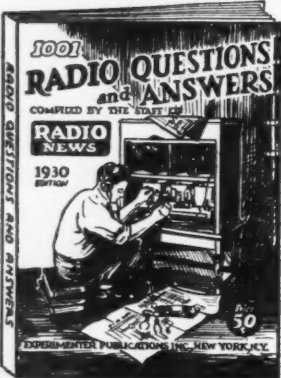
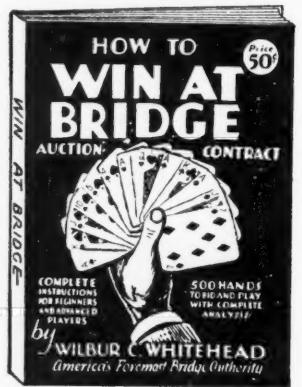
Sometimes called the Radio Amateur's Bible. Includes 10 How-to-Build articles, with complete instructions and diagrams; new radio wrinkles, DX hints, data on the new tubes, answers to AC problems, and helpful, money-saving ideas for the radio service man. 96 illustrated pages. Large 9 by 12 inch size. Beautiful colored cover. Price postpaid

50c

HOW TO WIN AT BRIDGE by Wilbur C. Whitehead

The world-famous Bridge authority's newest book. Tells how to play both Auction and Contract Bridge TO WIN! Complete rules of play and methods of scoring for both Auction and Contract Bridge. Contains 500 hands to bid and play, with complete solutions and analyses in back of book. The biggest 50c worth ever offered to Bridge fans. Printed in 2 colors. Hearts and diamonds shown in red throughout. 96 pages. Large 9 by 12 inch size. Beautiful colored cover. Price postpaid only

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1001 RADIO QUESTIONS AND ANSWERS 1930 Edition

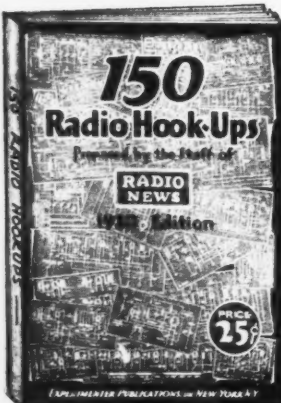
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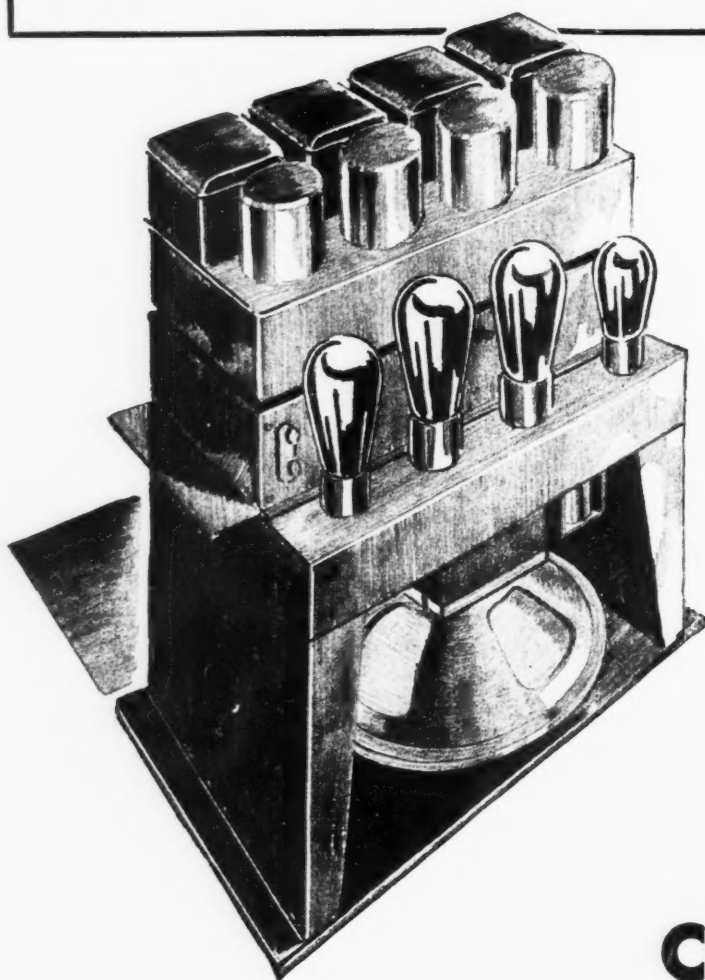
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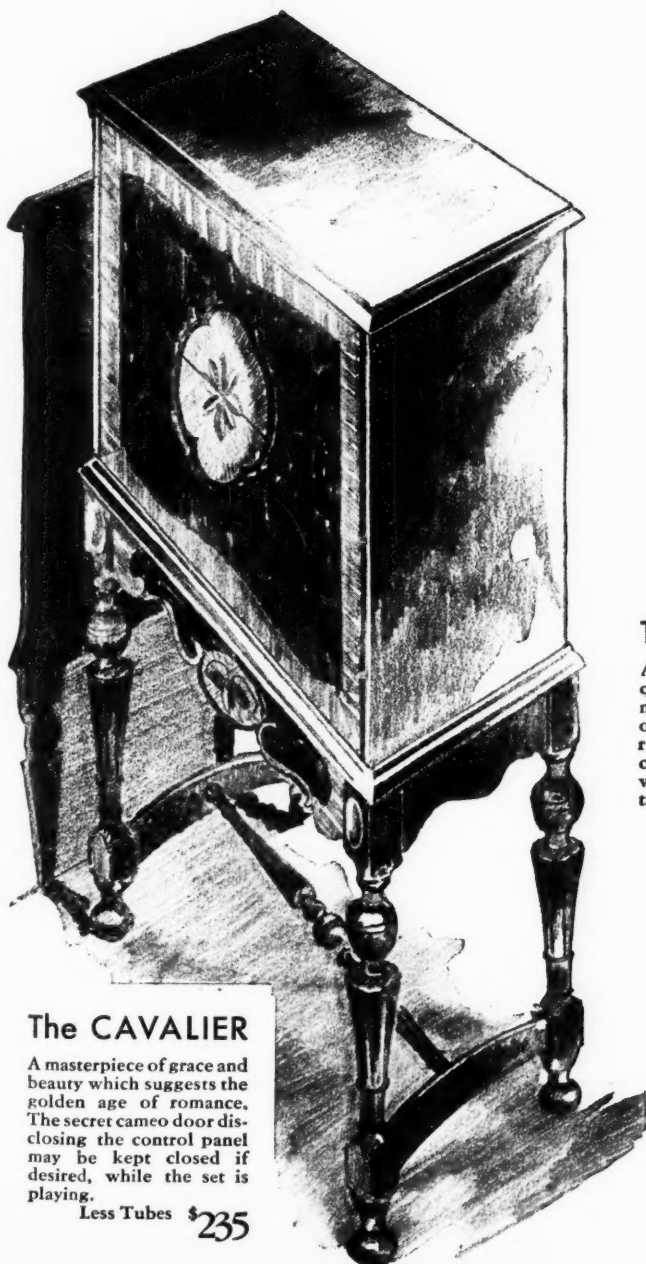
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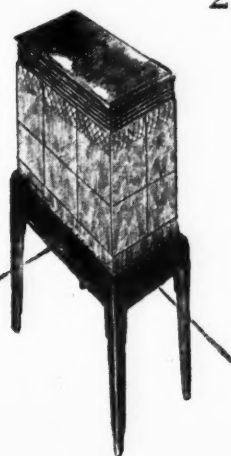
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Editorial



Radio for SMALL Pleasure Boats

WHEN we think of yachts and yachting, we naturally think of gaiety and entertainment. The proper use of a radio broadcast receiver aboard a yacht adds greatly to the pleasures of yachting.

It is our purpose to assist various Yacht Clubs and motor boat manufacturers in the development of an additional radio feature, far more important than the providing of entertainment alone. We contemplate the development of radio receiving equipment suitable for use on small as well as large boats, which may be used for entertainment and navigation purposes as well.

Many small boats are prevented from venturing any great distance from shore because their owners feel that such a venture would lack caution, particularly when there is no one

aboard who is familiar with navigation technique. The aviation industry is going to be largely responsible for a growth in deep sea navigation for small craft, because it will be possible for the small-boat owner to guide himself from port to port by picking up radio signals from airplane beacon transmitters, and by a simple process of triangulation determine his location at almost any time.

Work along these lines is well under way, and within a short time a description of the entire system will appear in the pages of this magazine.

Arthur H. Lynch

EDITORIAL DIRECTOR,
MACKINON FLY PUBLICATIONS, INC.

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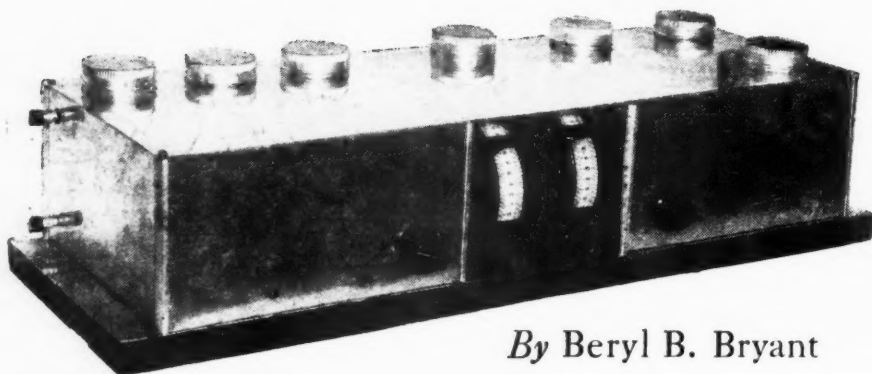
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Seven Tube



By Beryl B. Bryant

MAGISTER Tuner

THE writer prefers broadcast reception from stations outside the sphere of the local broadcast area. There are many reasons for this preference.

Consistent reception of distant broadcast stations on the loud speaker requires a powerful receiver. The selectivity must, of course, be in equal proportion to the amplification, yet must not produce distortion by side-band cut-off. To the writer, with the receiver described here, using a not-to-good antenna, medium powered stations located within a radius of three to four hundred miles are considered as locals. If the reader cares to investigate, he will find but very few receivers that are capable of consistent DX reception on the loud speaker, not to mention the lack of super-DX reception. He will not find such receivers to possess a sufficient degree of selectivity without side band cut-off to prevent the interference of locals.

With these things in mind, many trials and experiments were conducted before the final type of circuit and construction design was adopted. In passing, the author might mention that the "Home Builder's Seven," described in the April issue of RADIO NEWS, was the result of one of these experiments. It is remarkable to note the DX qualities of such a simple receiver as compared to the intricate works of receivers having the same qualities for DX. The writer might further mention that the greatest distance reception, of fair loud speaker volume, has been that of station JOAK of Japan. This was accomplished by one of the editors of SCIENCE AND INVENTION, who has confirmation of this reception. Other builders and friends report consistent reception of stations located on the west coast, Mexico, Havana, etc.

Thus the evolution of the receiver-tuner presented here has been after a long period of careful experimental work. The author believes this receiver, of most modern custom-built type, to be far superior to the many commercial receivers of similar type. Because of this belief the author has named the receiver the "Magister" (Latin for Master).

Inspection of the circuit diagram (Fig. 0) will show that six of the 224 and one of the 227 type tubes are used.

The first two screen-grid tubes, V1 and V2, beginning at the left of the diagram, are tuned r. f. amplifiers. Their wavelength band extends over 200 to 550 meters. These circuits are not of the band pass type, although they are inductively coupled. Due to the characteristic of the screen-grid tube, the 1:2 primary-secondary winding ratio and type of inductances used, a degree of broad tuning is prevalent. This broad tuning is desirable, purposely brought about to enable ease of tuning over the band without the necessity for the use of compensating condensers to obtain exact resonance at all wave-lengths.

The third screen-grid tube, V3, is used as a new type of modulator. However, a similar circuit has been employed in Europe for some number of years, differing only by characteristics of the tubes. The screen-grid of this tube is modulated by the oscillator and obtains as well its "B" plus potential from the plate of that tube. The manner in which the modulator tube mixes the frequencies is similar and almost identical with the three element modulator of the late R. E. Lacault's Ultradyne circuit. As the screen grid of the tube requires a definite "B" plus potential, its return is made to the plate of the oscillator tube instead of the grid, as in the case of the Ultradyne. The voltage of both the screen-grid and plate are somewhat critical depending upon the r. f. gain of the preceding stages. Using this tube as a modulator gives the advantages of amplification by virtue of

plate supply as used with the old first-detector type of mixer and at the same time has the same degree efficiency and sensitivity of modulation as found in the Ultradyne circuit. Before passing on those who may desire to use this type of modulator in the "Home Builder's Seven" may do so with ease, and to great advantage. The normal screen-grid and plate potentials of the tube should be used in this case.

The modulator tube feeds into two screen-grid intermediate-frequency band pass stages of the inductively coupled type. The degree of coupling has been made adjustable for the degree of band pass desired. The intermediate-frequency stages are designed for 250 kilocycles with a from 5,000 to 15,000 cycle band pass. The 1200 meter or 250 kilocycle frequency was selected in order to approach as nearly as possible one spot tuning and to enable ease of construction of the tuned band pass filter inductances at the lowest possible cost.

Power Detector

The sixth screen-grid tube, V7, is of the power detector type using "plate bend" rectification. No provision has been made on the chassis for coupling to the a. f. amplifier other than the detector

Fig. 1. In laying out the parts for the Magister it is well to follow the picture layout below and the photographs accompanying

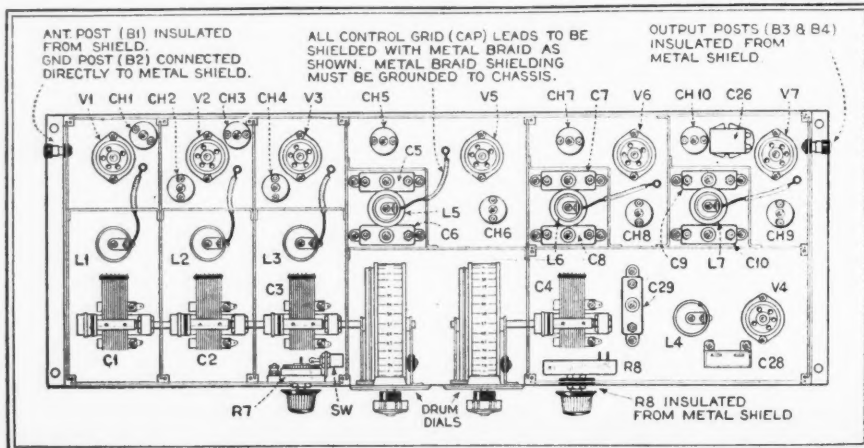


plate lead. The series plate resistor could of course be incorporated on the chassis but as the complete audio and power system are contained in another chassis, it was not considered advisable because of possible circuit reaction, as doing so would necessarily make the grid lead of the succeeding a. f. stage of considerable length. This would be subject to a great many disturbances as can be seen. With many stations, all locals, it will be possible to eliminate the first a. f. stage, coupling directly to the power stage. Sufficient gain to load the 245 power tube may be had in this manner to supply volume suitable for most home use. The detector plate-feed resistance should have a minimum value of 250,000 ohms. The a. f. return is made to the cathode of the detector through a bypass condenser connected to B4, while the "B" supply is obtained from the power supply in the conventional manner. The detector r. f. by-pass condenser, C 26, is also returned to the same point. A capacity of .001 mfd. is used here for filtering of the high audio frequencies. Should these frequencies be desired, the capacity may be reduced to .0005 mfd. and in some instances a capacity of .00025 mfd. will prove satisfactory. The above returns are not made to "B" minus as is usually the case, as, even though the detector bias resistor is by-passed by a 1 mfd. condenser, C 25, there still remains the reactance of this condenser in the circuit. This reactance would tend to attenuate some of the very low audio frequencies.

Suitable Audio-Frequency Amplifiers

The a. i. amplifier may be of any type, within certain restrictions. In a following issue of this magazine will be described a suitable amplifier and power supply. This amplifier employs one stage using the 227 type tube, coupled to the detector through the proper grid blocking condenser, in connection with

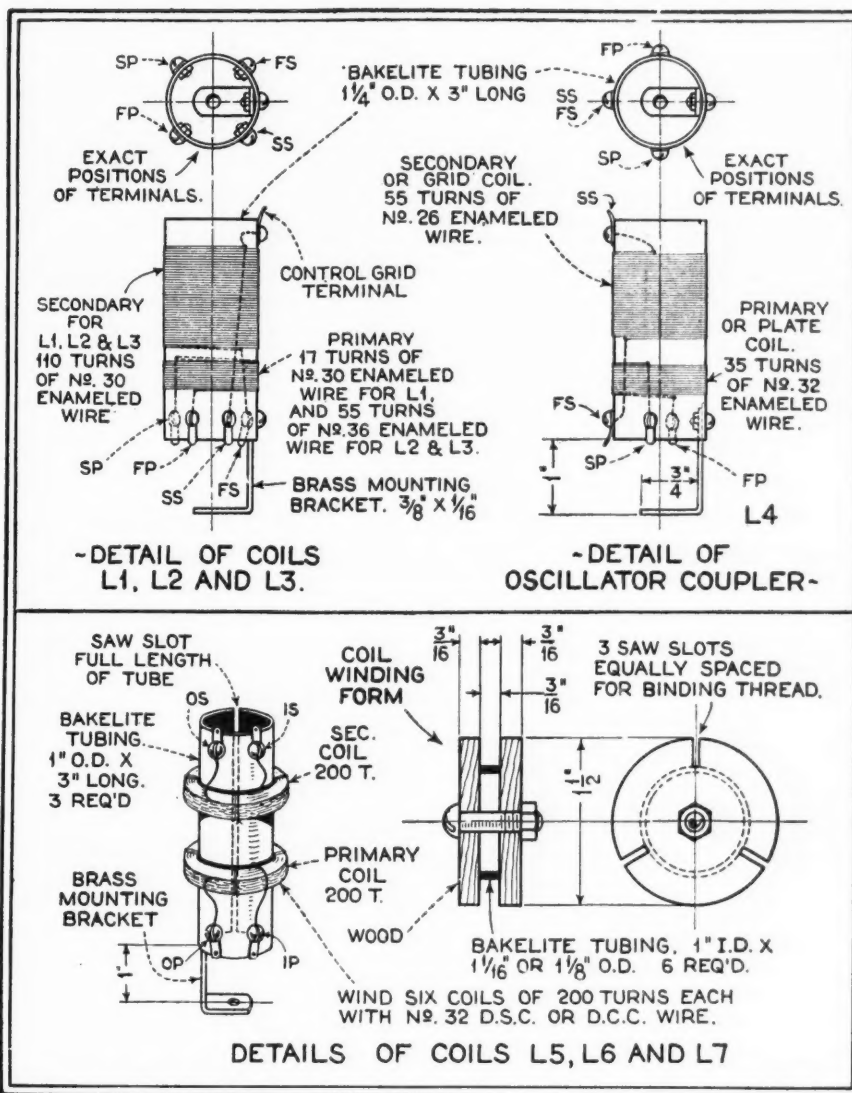
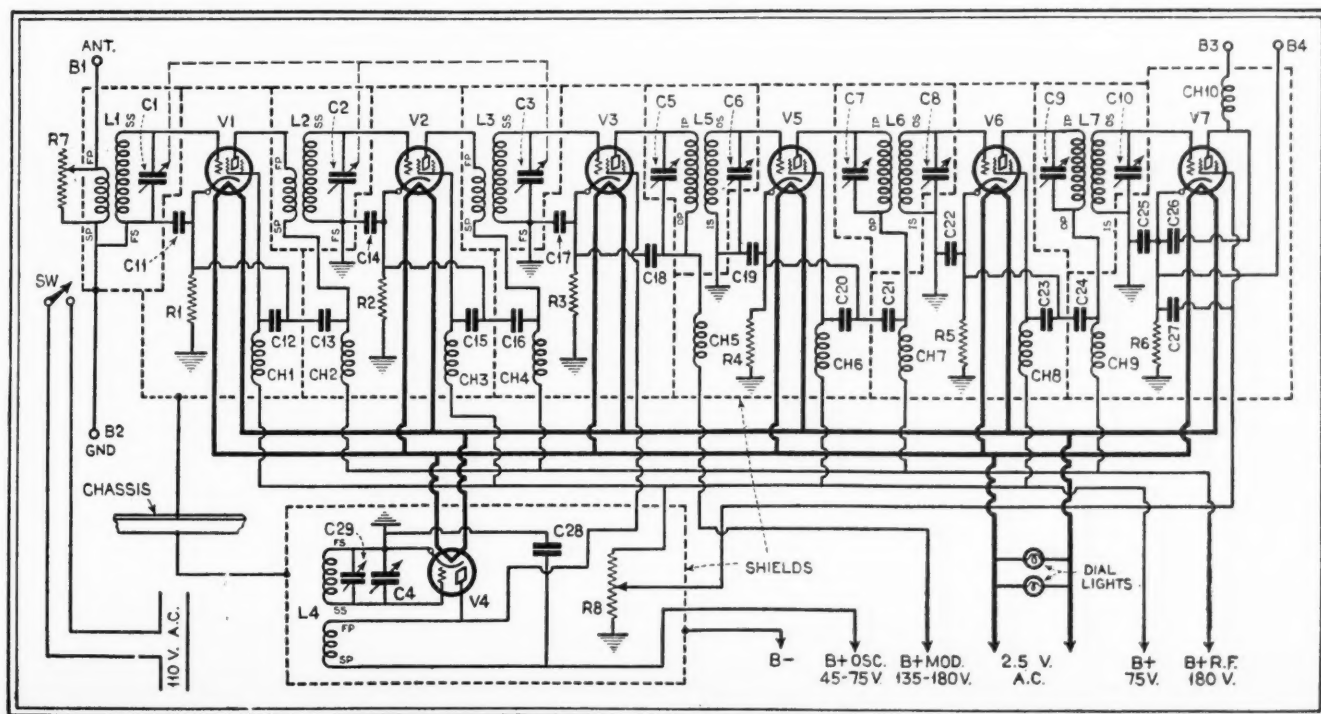


Fig. 2. Full constructional details for all the coils employed in the tuner are given above. Compare the terminal markings with the schematic circuit shown in Fig. 3

Fig. 3. Here is given the complete circuit diagram for the Magister tuner. The parts are numbered to coincide with the parts layout and parts list.



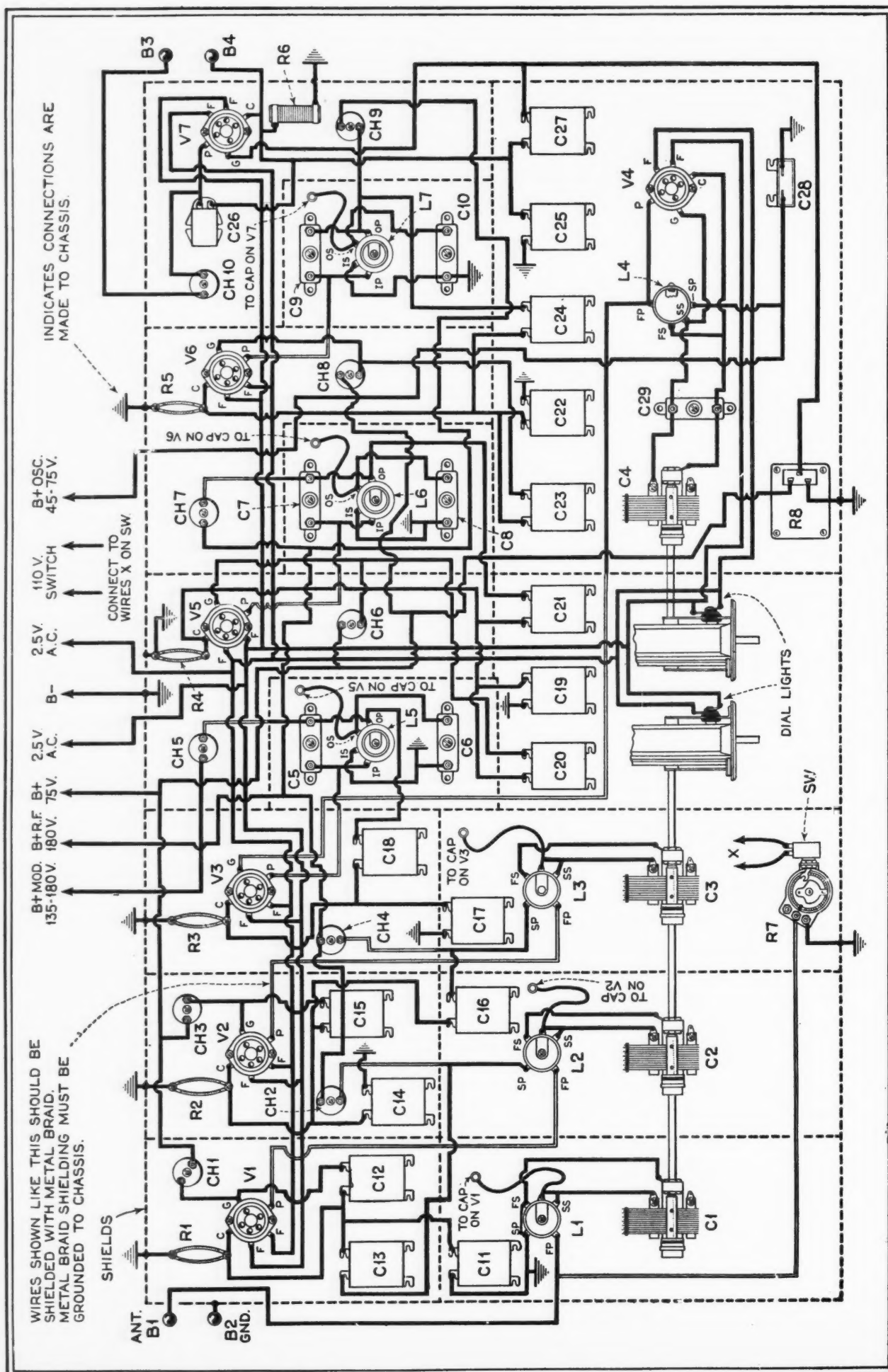
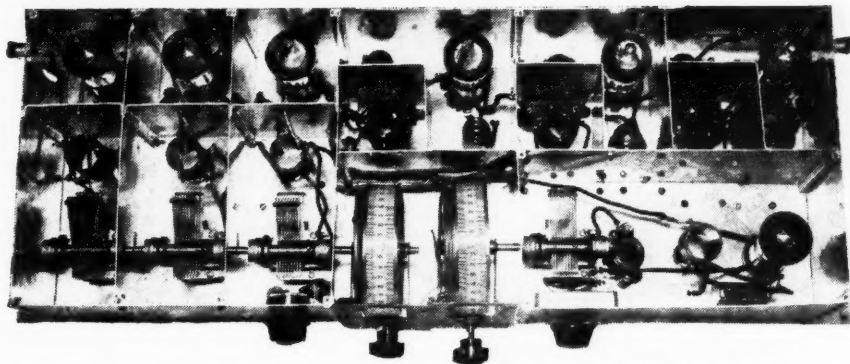


Fig. 4. All the parts, together with their connecting wires, are shown in the relative positions they will take in the completed set



How the Magister looks when completely built

the detector plate-feed resistor. The first a. f. stage is followed by a push-pull stage in which the general purpose power tube, the 245 type, is employed. Such a combination when used with the r. f. amplifier-tuner described here will deliver more than ample power for ordinary purposes and serves to lessen the cost of the complete receiver.

Mechanical Construction

The chassis construction of the "Magister" is of improved design and is simple in construction. It is constructed of such material that lends great strength to the assembly, serving as a base of support and common electrical connection. The aluminum shield compartments have been built as a part of the chassis. The bottom of the shield compartments is a single large piece of aluminum the same thickness as used for the partitions, sides and top.

Selection of Parts

While the constructor will naturally desire to use what parts he may happen to have on hand that will fit into the circuit, it is recommended that rather than chance possible trouble, the parts listed below be purchased new and triple tested as to defects. These parts have been selected with both a view toward the expense, and to their efficiency of operation in the circuit. Size in many cases has also been a factor for selection.

However, should different parts be used, care should be taken that additional space be allowed for them when building up the chassis. The chassis has been made as small as possible; as a matter of fact has been built around the parts. The parts required for duplication of the official "Magister" tuner are as follows: Four Hammarlund .00035 mfd. tuning condensers (C1 to C4).

Two National drum dials, type F.

Ten Pilot 80 millihenry chokes. Inductances smaller than these are worthless in the Intermediate stages (Ch1 to Ch10).

Seven Pilot UY sockets, type 217 (V1-V2-V3-V4-V5-V6-V7).

Seventeen Flectheim 1 mfd. by-pass condensers-250 volt d. c. rating (C11 to C25, C27 and C28).

One .001 mfd. Flectheim midget fixed condenser (C26).

One Antenna Coupler, home-made or commercial (L1).

One Oscillator Coupler (L4).

Two Screen-grid r. f. couplers, home-made or commercial (L2 and L3).

Three Intermediate band-filter transformers (L5, L6 and L7).

Six XL Laboratories Vario-densers, type G5 (C5 to C10).

One XL Laboratories Vario-densers, type G1 (C29).

One Electrad 50,000 ohm Truvolt fixed resistor with tap for detector bias (R6). Ten Electrad 1400 ohm grid suppressors for Screen grid tube bias. (Important see paragraph on tubes.) (R1-R2-R3-R4-R5.)

One Electrad volume control type AP (R7).

One Electrad Super Tonatrol No. 5. 0 to 100,000 variable resistor (R8).

Four XL Laboratories "bakelite top" binding posts (B1 to B4).

Six Carter Control grid connector caps.

Six Hammarlund slotted corner posts (obtainable directly from manufacturer).

Six Hammarlund slotted partition posts (obtainable directly from manufacturer).

One sheet aluminum 29 x 10 x 3-64 inches. One sheet aluminum 27 3/4 x 10 x 3-64 inches.

Six sheets aluminum 9 1/2 x 5 1/4 x 3-64 inches.

One sheet aluminum 27 1/4 x 5 1/4 x 3-64 inches.

Three sheets aluminum 10 1/8 x 5 1/4 x 3-64 inches.

One sheet aluminum 7 3/8 x 5 1/4 x 3-64 inches.

Three sheets aluminum 6 3/4 x 5 1/4 x 3-64 inches.

Three sheets aluminum 4 x 5 1/4 x 3-64 inches.

One sheet aluminum 5 1/2 x 5 1/4 x 3-64 inches.

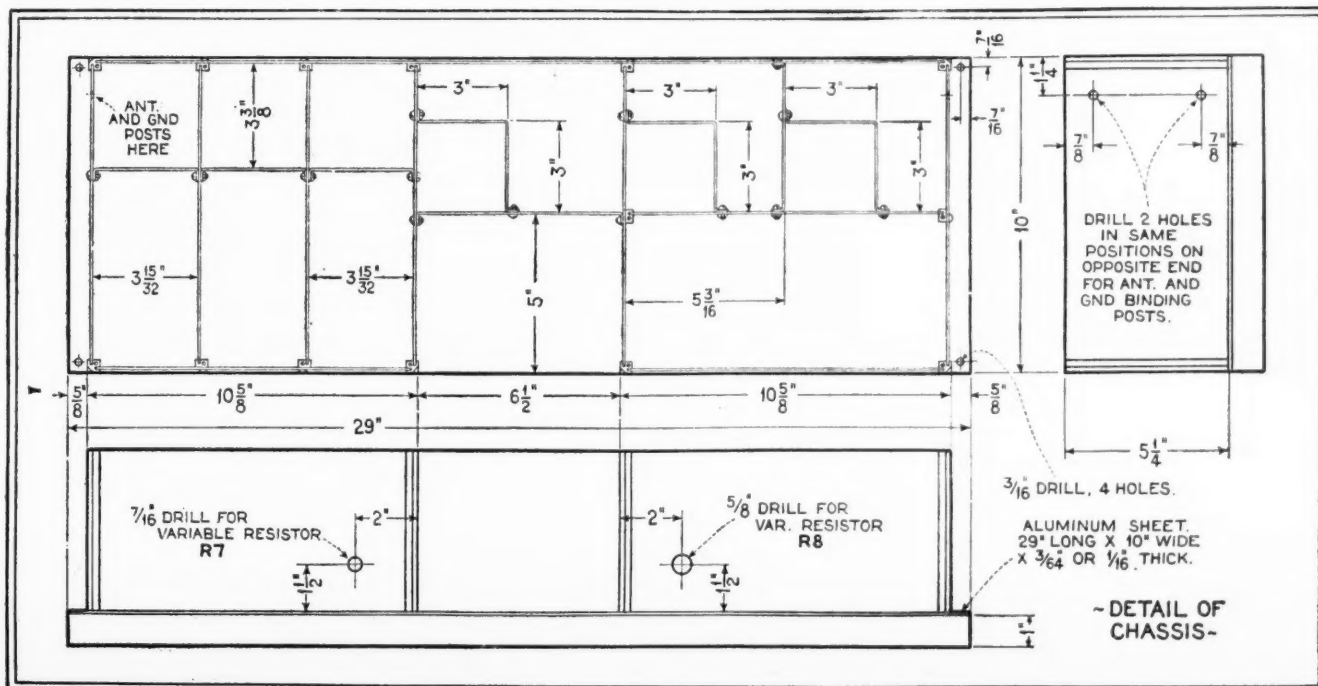
Seven aluminum caps (salt and pepper shakers 2 1/4" diameter by 3" high, the bottoms of which are used as tube port hole covers).

Six Speed type 224 tubes, new type (see paragraphs on tubes). (V1-V2-V3-V5-V6-V7.)

One Speed type 227 tube (V4).

Four pieces bakelite tubing 1 1/4 inches in diameter by 3 inches long (for L1, L2, L3 and L4).

Fig. 5. Not only the coils, but also the tubes are located in shielded compartments, laid out as shown here



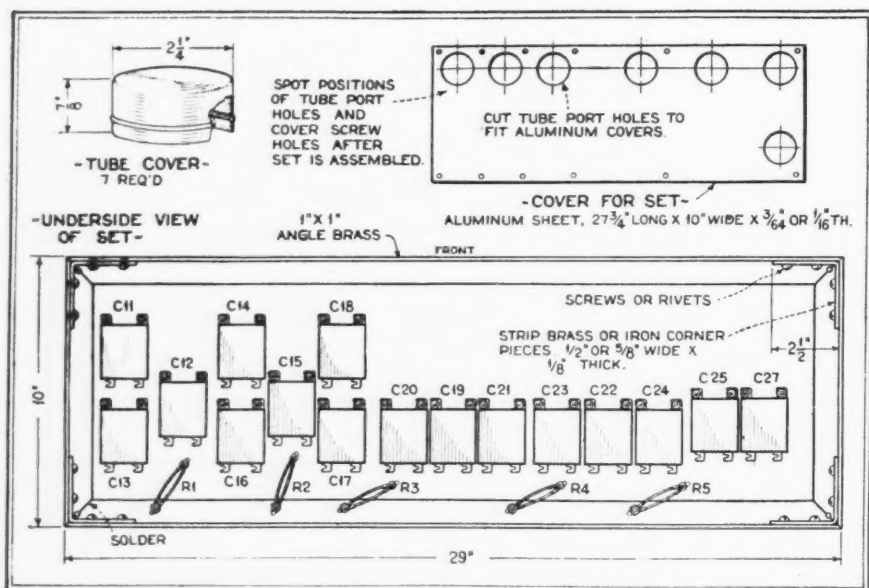


Fig. 6. Details for mounting the various by-pass condensers, location of the tube caps, etc., are given above

Three pieces bakelite tubing one inch in diameter by 3 inches long (for L5, L6, and L7).

Six bakelite rings one inch in diameter by 3-16 wide (core pieces for coils of L5, L6 and L7).

Two pieces angle brass 29 3/4 inches long by 1 inch by 1/8 inch thick.

Two pieces angle brass 10 inches long by 1 inch by 1/8 inch thick.

Four iron corner angles 1/2 inch wide 1/8 inch thick and 2 1/2 inches long.

Construction of Coils

The antenna and r. f. coils used in the "Magister" must be of the small field, small diameter type in order that coupling between the r. f. stages is minimized. Otherwise the shielding would prove to be inadequate. Various commercial coils may be obtained on the market that will prove satisfactory when properly modified. The coils are easy of construction and although the commercial product may be obtained for a reasonable cost, the constructor can as easily make them himself.

The secondary windings of L1, L2 and L3 consist of 110 turns of number 30 gauge enamel insulated wire wound on 1 1/4 inch diameter tubing. The winding will require a space of approximately 1 1/4 inches. The antenna primary of L1 is wound with 17 turns of the same size wire. The primaries of L2 and L3 are wound with 55 turns of number 36 enamel covered wire. The winding space required will be approximately 3/8 inch.

The primary and secondary windings are separated by a space of 1/8 inch. Both windings should be in the same direction. The start or beginning of the secondary winding, designated (S) connects to the control grids. The finish, designated (F) connects to "B" minus. The start of the primary, nearest (F) of the secondary, connects to "B" minus in the case of the antenna primary and to "B" plus 180 volts for the r. f. coils. The finish (F) of the primary of the antenna coupler connects to the antenna

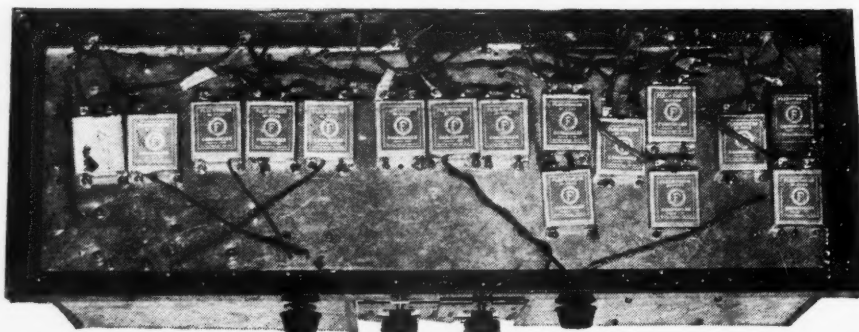
binding post (B1) and also to the antenna volume control (R7). The finish of the RF primaries connects to the plate of the tubes.

Special Oscillator Coupler

Inasmuch as the wave length range of the oscillator coupler is considerably different from the other coils, this coupler must be constructed by the builder. It is wound on the same diameter tubing as used for the antenna and r. f. coils. The grid or secondary winding consists of 55 turns of number 26 enamel covered wire. The primary or plate coil consists of 35 turns of number 32 enamel covered wire. The two windings are separated by 3/8 inch. The use of smaller wire for the primaries of the above coils has proved more satisfactory, especially in the case of the oscillator coupler. Its use tends to minimize the production of parasite harmonics by the oscillator as well as overcomes unstable generation as is the case when larger size wire is used.

After the above coils have been wound they are provided with lug terminals for soldered connections. Unless the windings have been made very tight it will be necessary to dope them with very thin celluloid cement. This cement should be used very sparingly in order to cut down distributed capacity. Detail construction of coils is given in Fig. 2.

Below the base are located the numerous by-pass condensers and a good part of the actual wiring of the tuner



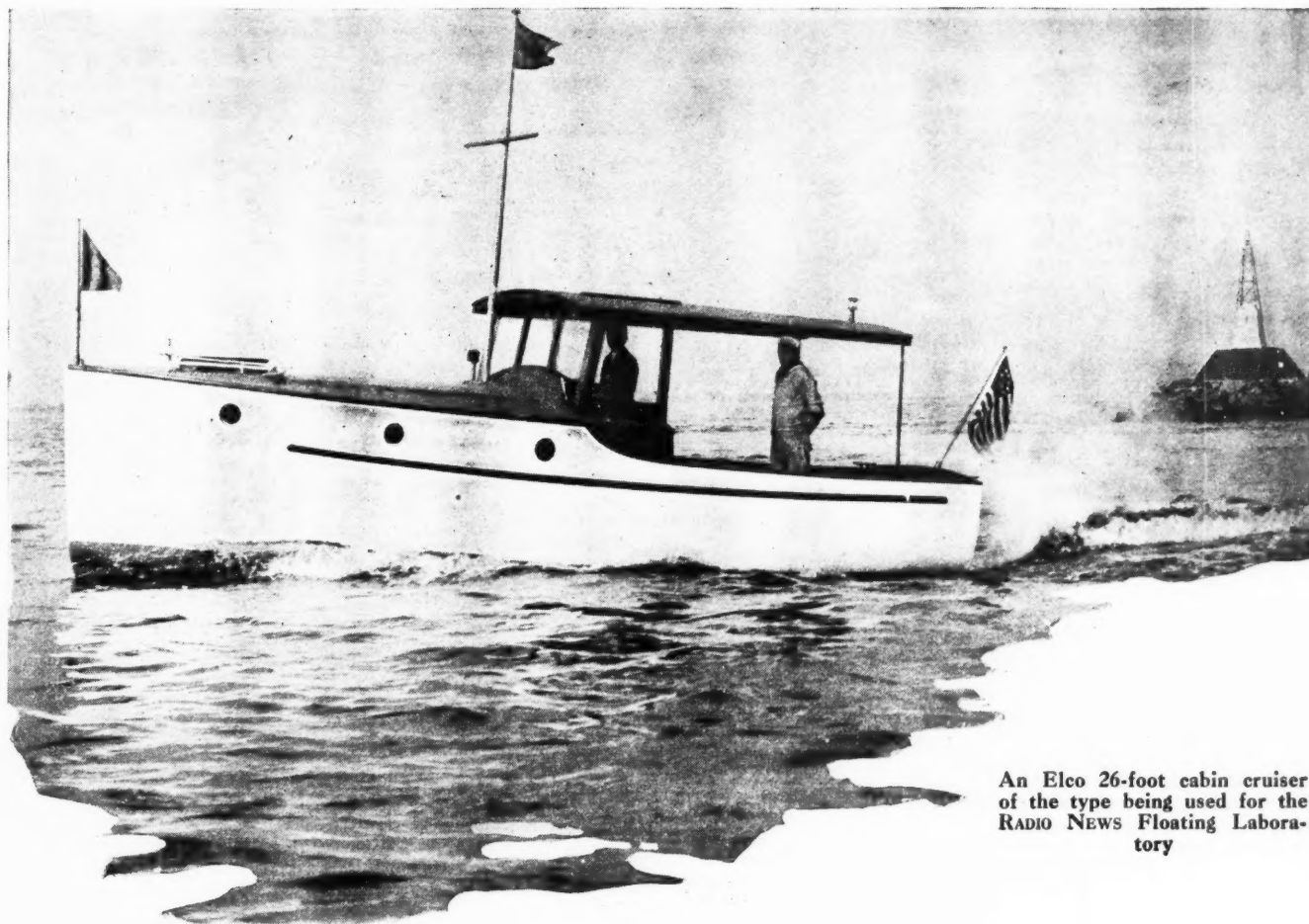
Making the Intermediate Band Filter Transformers

The construction of the coils used for the band filter transformers is very simple. While lateral wound coils are desirable, bunched slot wound coils will prove just as satisfactory providing they are carefully made and matched. The latter process may be accomplished by using one of the coils as the grid coil of a modulated Hartley oscillator, and should be shunted by a .00035 mfd. condenser. Placing the other coils in turn, in series with a crystal detector and a pair of phones, the coil to be matched shunted by a .00035 mfd. condenser, the number of turns are adjusted until the signal is loudest. Use of a variable condenser with some sort of scale will expedite this work.

For the coil construction, six bakelite rings one inch in diameter and 3-16 inch in width are required. These rings are clamped, in turn, between side pieces which should have a diameter of not less than 1 1/2 inches. The wire is wound in the resultant slot. The detailed construction of the above described form is given in Fig. 2. The side pieces, as shown in the detail sketch, should be provided with three slots equally spaced around the circumference. The depth of these slots should not be less than 1/4 inch. Each disc is provided with a hole drilled through the center. The discs with the bakelite rings are assembled and clamped together by passing a machine screw of sufficient length through the assembly and tightening with a nut. The discs can be made of any stiff material, preferably bakelite 1/8 or 3-16 inch thick. When the form has been assembled, the slots of the side pieces should be aligned and a length of strong linen thread placed in each slot across the surface of the bakelite rings. The tie strings are used to hold the winding in place and shape after the side pieces have been removed and until the coil is doped.

Six coils are wound, each with 200 turns of number 32 DSC or DCC wire. When wound each string or thread is tied around the winding, at which time the side pieces may be removed. No excessive care of winding the wire in the slot is necessary. The more the scramble, the better, as this will result in a coil of lower distributed capacity. When all the slot wound coils have been made and the side pieces have been removed, the constructor will have six coils with a bakelite core. These coils are now soaked in thin celluloid cement, allowed to stand until the cement begins to set, at which

(Continued on page 372)



An Elco 26-foot cabin cruiser of the type being used for the RADIO NEWS Floating Laboratory

By W. Thomson Lees
Managing Editor

Radio News FLOATING LABORATORY

*Promoting Entertainment, Navigation Aids
and Communication by Radio for the
Pleasure-Boat Owner*

BY the time these pages are in print the experimental work of the technical staff will be well under way, looking toward the development of—first, a receiver, and later on a transmitter—which will afford to the small boat owner all that he has a right to look for from radio. This means not merely entertainment, but weather reports, time signals, direction finding; in short, *real* radio service.

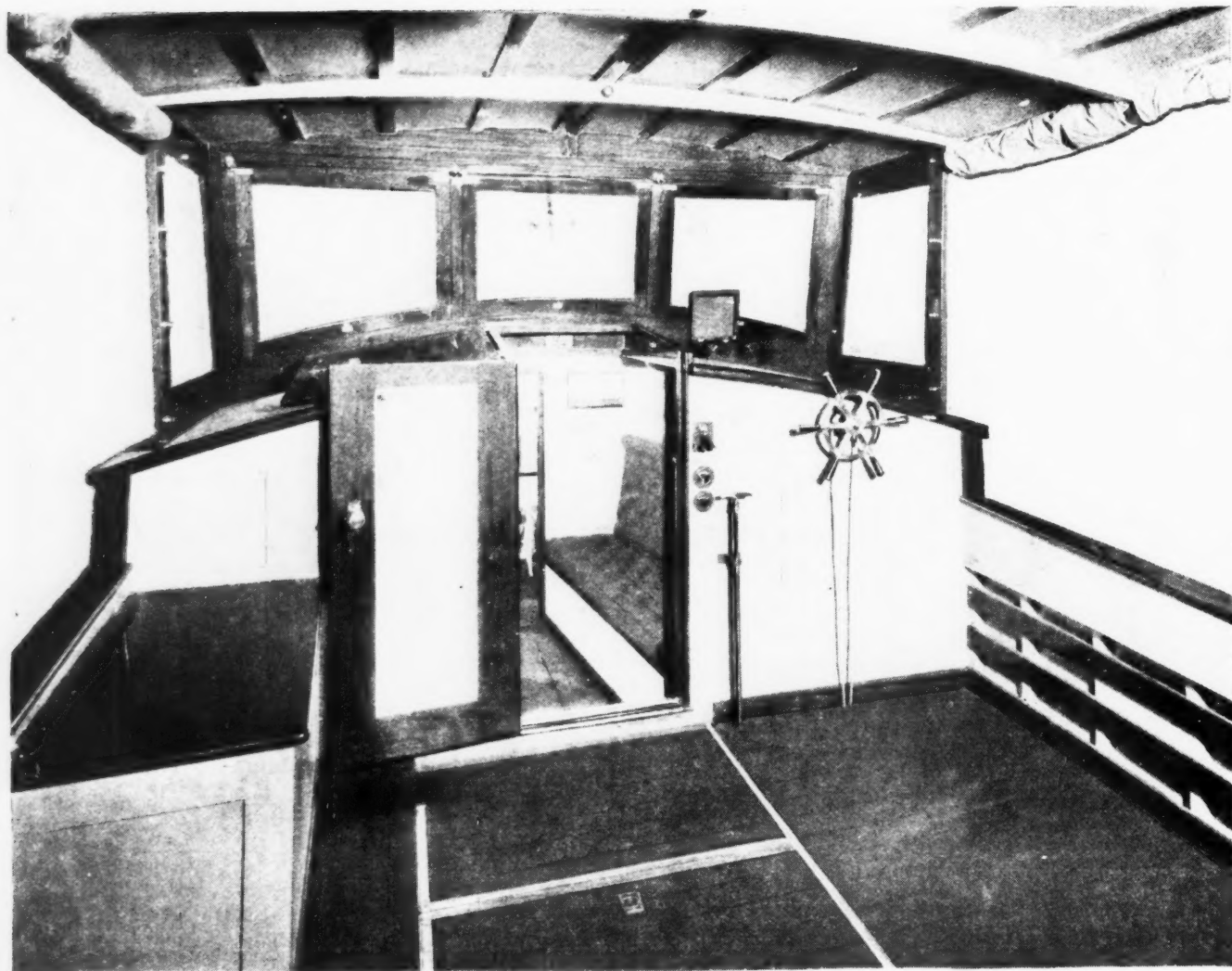
In our November issue we will present a complete account of this work up to the time of going to press.

IN the case of worthwhile radio ideas, no less than in golf, the important thing is the "follow through." Last month, we had Mr. Lloyd Jaquet present (RADIO NEWS, September, 1929, page 212) the question "Why Not Get the Utmost from Radio on Your Pleasure Boat?" Well—why not?—was the question that kept humming in the heads of the editorial staff. Since everybody we asked seemed to think the answer worth finding, we decided to go after it.

In the first place, there are thousands of pleasure boats plying the waters of these United States, serving as vacationing headquarters for their owners. These boats range from small launches

to medium-sized and big yachts; but probably the greatest number of them lie within the sizes from about 25 ft. to 50 ft. of the small cruiser type, if we eliminate the ones that are used only for *getting* somewhere, rather than for *being* somewhere.

It is perfectly true that some of the larger sizes of these boats are (in a manner of speaking) "equipped with radio." Not one of them, as a matter of fact, is really equipped with a radio installation that enables its owner to get even a fraction of what radio can give him in the way of (1) safety, (2) aid to navigation, (3) time and weather information and (4) entertainment. Why not?—because,



as yet, there simply "ain't no such animal."

Note that we said, above, that some of the larger cruisers are furnished with radio equipment. This means, simply, a radio set for entertainment; except in the case of boats more properly classed as yachts, in which case a licensed commercial operator is carried.

What we are interested in, is the owner-operated cruiser, used for week-end trips or even more lengthy cruises. We want to develop a receiver that will be almost as important to the owner of this type of boat as his rudder. It has to be ready to while away the time, when all's well, with really high quality entertainment from broadcasting stations; it has to be capable of serving as a direction-finder; it must reach up to the wave-bands on which marine beacon stations operate; it must reach down to the short wave-bands. (The last-named requirement will be enlarged upon, later on.)

With all this, there are other requirements to be met. First of all, ignition interference must be faced and conquered. Next, the set must be so designed as to defy the ravages of salt water. Last, but decidedly not least, both the receiver and its power supply must keep within rather rigid requirements as to size and weight.

In case this brief summary of the conditions to be met is not enough, a more elaborate outline was contained in our

Looking forward from the stern of the cockpit. The engine being located under the hatch (in the middle foreground) puts the source of ignition interference practically amidships. It is obviously impossible to locate a receiver far enough away so that distance alone will eliminate this interference

previous issue. However, it is one thing to discuss these requirements in the abstract, and quite another thing to attack them concretely. We have, of course, the RADIO NEWS Laboratory; and we intend to make use of it. But we might develop a theoretically beautiful receiver for small cruisers, in the Lab, only to have it turn out that actual practice on a boat is something else again. Obviously, the proof of the pudding lies in the eating.

As this is written, the writer has just returned from a brief trial trip on the newest extension to our laboratory facilities: a 26 ft. Elco cabin cruiser, put at our disposal for this purpose by the Elco Boat Works, of Bayonne, N. J. As described by the manufacturers, this boat is "the smallest practical cruiser"—which makes her ideal for our purpose; because she offers every handicap of size and space, and the results of our experiments will therefore be applicable to cruisers of all sizes.

The trial trip referred to was merely a short run, out in Newark Bay. By the

time these lines are in print, however, we expect to be so familiar with our floating laboratory as to call every plank by its first name. More important, by dint of night work and week-end efforts, we expect to have some interesting practical data to unfold before another month rolls around.

We might mention, parenthetically, that if you don't own a boat, or if you don't know a man who owns one, you're missing something. If you live up North, here, you're missing something from April to October; if you're down below the freezing line (or, rather, down *above* it) you're missing something, the year around. No dust; no crowded roads, no need to follow a concrete ribbon—but we'd better pipe down (note the influence of that trial spin) and stick to our subject.

First, then, we're going to go after the bugaboo of interference from the engine. If you have to shut off your motor every time you want to listen to a good radio program, you can't cruise very far. More important, if you get caught in a fog, you don't want to lose steerage-way every time you try to catch a direction-finding signal.

Once we have interference lashed to the mast (getting nautical, again) the other problems will be taken up piecemeal. Circuit possibilities are, of course, many; arrangement of parts, selection of parts, selection of tubes; all of these, and many more, are variables. In a way, it is like

trying to solve an intricate algebraic equation having a dozen or so unknowns and only two or three known factors. Which is exactly why the only practical approach lies in a method of "cut and try."

The known factors are: that where the small size of the boat precludes locating a receiver far from the engine, interference from the ignition system is inevitable; that a highly efficient antenna system is out of the question; that weight and size of the receiver must be kept down, because of space limitations on board; that A and B power supply must be suited to the conditions involved.

Oh, yes; there is one additional known factor which we forgot to mention: the name of the boat. If we find time, we'll hold appropriate christening ceremonies; if not, she will have to be content. At any rate, she will bear the dignified title **RADIO NEWS FLOATING LABORATORY.**

The illustrations on these pages give a fair idea of what our floating Lab. looks like. While not pictures of the boat itself, they are views of one of her sister ships, as like as two peas in a pod. The cabin has sleeping accommodations for four (not that we expect to find much time for sleep, during the coming month!) and the cockpit is almost as large as the average nightclub dance floor.

Powered with a 27 h.p. engine, this cruiser makes about ten miles per hour—no challenge to the Bremen, but plenty fast enough to keep going. As will be seen in the illustration taken from the rear of the cockpit, looking forward into the cabin, there is a flush deck hatch immediately aft of the cabin doorway. Under this hatch is the engine, with its electric starter, as well as the storage battery which operates both the starting and lighting systems.

Under that hatch, therefore, is the source of our first major problem: ignition interference. On a fifty-footer it is possible to get a radio set far enough away from the engine to minimize such artificial static; on a twenty-six footer, with the engine almost amidships, that won't work. Whether it will be a case of only special spark plugs and partial shielding, or whether more elaborate methods will be required, will not take very long to determine.

There isn't the least doubt that the Floating Laboratory's cockpit is plenty

The Mouette, famous honeymoon cruiser of Col. Lindbergh and his bride. It is boats of this type, ranging from 25 to 50-foot in length, that have found the widest popularity, and it is for this class of boat that all-around radio service is as yet unavailable

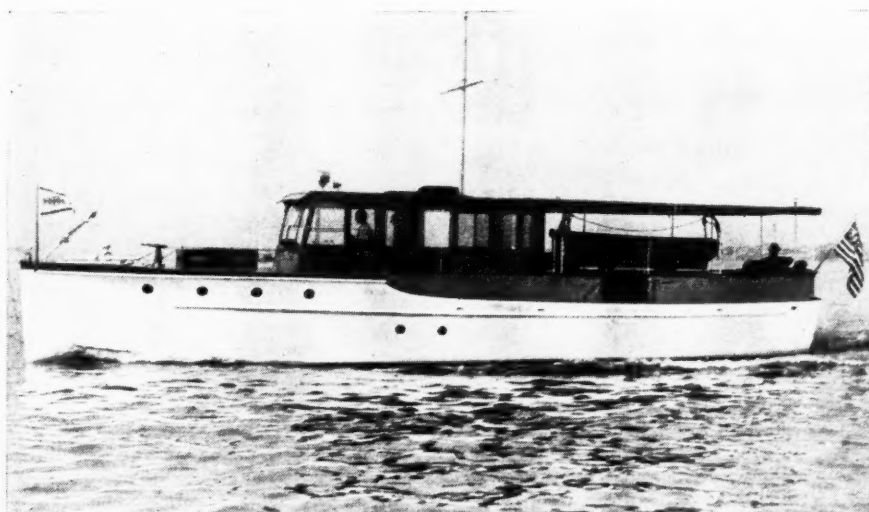


large enough to permit putting there a most elaborate console type radio set with built-in dynamic speaker. Nor is there any doubt of what would happen to console and set, after the spray from a few whitecaps had played around with them. Nor is there any 110 volt a. c. floating around the water these days. No—the a. c. receiver is definitely out.

We are, however, going to take a variety of battery-operated receivers aboard, for comparative tests. And these, incidentally, will give us a line on the efficiency of signal pick-up, as compared with the ordinary home location.

It is obviously impractical to do any amount of actual constructional work on board. That, of course, will have to be done at our base laboratory. If it were not for that—and the comparatively insignificant details of editorial desk work—we might be tempted to forsake the

A 50-foot cabin cruiser. Many boats of this size are equipped with radio, but usually only for entertainment purposes



crowded city and embark on an extended cruise. But, being fully alive to the importance of radio—*real* radio—in such a venture, we'd much rather wait until we have developed the receiver for the job.

Too many people measure radio solely by the standard of broadcast entertainment. They know only vaguely, if at all, that there are such things as radio beacons, weather reports, storm warnings, time signals. If it were merely a case of designing a "salt-air proof" receiver in more-than-usually compact form, so that a boat owner could bring in a jazz program or a concert to while away the time, the whole proposition on which we have embarked would be hard to justify.

At the same time, until boat owners learn how radio can serve them, there would be scant interest in a specially-designed receiver which ignored the broadcast entertainment feature. And, with the other more difficult requirements we have mapped out, it is comparatively simple to include good broadcast reception.

But, as we said earlier in this article, the proof of the pudding lies in the eating. We want you to know what we are doing and planning, but your real interest lies in the concrete results of our work, and not at all in long-winded discussions of how we are going about getting these results.

When this issue of **RADIO NEWS** reaches you, we will already be seriously and intensively at work—three men in a boat.

In the next issue, we confidently expect to have some worthwhile reports to make. Until then—**RADIO NEWS FLOATING LABORATORY**, signing off.

How to Build a 245 AMPLIFIER

for the RADIO NEWS Foundation

RADIO NEWS readers who have constructed the R-N Foundation Tuner described in last month's issue of this magazine are undoubtedly ready to add to it some acceptable type of amplifier; that is, if they have not already done so. This article concerns itself primarily with the description of a suitable amplifier and power supply device, and secondarily with the instructions governing the installation of a tuner and amplifier power supply device in a console cabinet, which also houses an electrically-operated phonograph with magnetic pick-up.

General Considerations

In designing this unit intended purposely for use with the RADIO NEWS Foundation Tuner Unit, several considerations had to be kept in mind. First, a suitable audio channel had to be provided, so that the high level of signal developed by the tuner unit could be handled satisfactorily without overloading. To satisfy this first demand, a pair of 245 tubes have been used in the final or power audio amplifier stage. It is preceded by a stage of audio amplification employing the 227 tube. Reference to the circuit diagram Fig. 1, will show the connections for the entire audio channel. Secondly, the device had to supply not only an audio channel for the tuner unit but also the "B" supply for the plates of the various audio amplifier tubes and also for the plates of the tubes employed in the tuner unit. Thirdly, it had to supply the a. c. filament voltage to the

tubes in the audio amplifier and tuner units.

In the Thordarson power transformer employed in this power supply device, the filament voltage for the audio amplifier tubes is readily obtained by a filament supply winding provided for the purpose, but for the tuner unit a separate filament transformer, supplying the correct filament voltage, must be obtained. The filament transformer selected for this purpose is designed to supply current to four a. c. tubes of the 227 or 224 variety, three in the tuner and one in the audio channel. If the amplifier-power supply device described here is used with any other tuner unit employing more than three a. c. tubes, then another type of transformer which supplies the correct filament voltage at the correct amperage, depending on the number of a. c. tubes employed, will have to be used.

Considering that the entire installation is to be housed in a console cabinet containing an electrically driven phonograph motor with magnetic pick-up, the fourth requirement that this unit had to meet, was the ability to change readily from the radio tuner unit to the phonograph pick-up, when desired. As will be seen from the circuit diagram, Fig. 1, a number of switches have been employed to make this possible. In Fig. 2, the position and location in the circuit of these switches, is shown. The double-pole double-throw jack switch, SJ, is used to connect the power amplifier to either the RADIO NEWS Foundation Tuner Unit or any other suitable tuner device, when in one position and to the phonograph

pick-up when in the other position. Control of the filament supply of the tuner unit is independent of this switch and must be operated separately when the radio receiver is to be turned on or off. Similarly when the phonograph is to be turned on, then the line switch in the phonograph motor cord which plugs into the 110 volt a. c. supply, must be turned on to start the turntable motor. It will be also noted that there is a pendant switch to control the 110 volt a. c. supply to the audio amplifier-power supply line transformer.

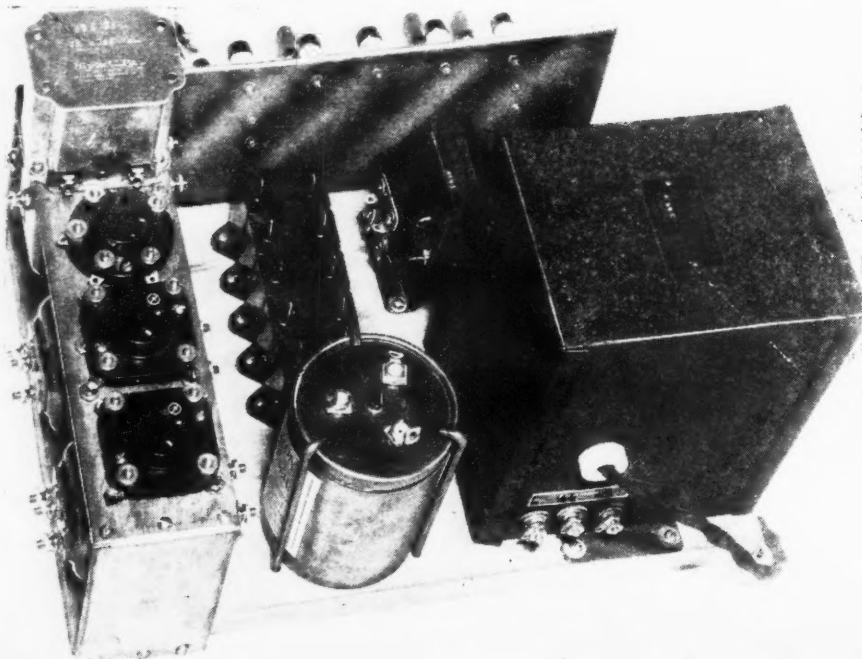
The Audio Amplifier

In all, four transformer units are employed in the audio channel. T1 is the input transformer which couples the plate of the detector tube of the tuner unit to the first amplifier tube. This first stage, which employs a 227 tube, inputs directly into an intermediate stage push-pull transformer. This, in turn, connects to the grids of the two 245 power amplifier tubes and then from the plates of these tubes to the primary of the output transformer. The secondary of the output transformer connects directly into the voice coil of any suitable type of dynamic speaker or to the existing types of approved magnetic speakers. The fourth transformer employed, T4, is a phonograph-coupling transformer and is used to couple the phonograph pick-up to the primary of the first stage audio transformer, T1. By its use, the impedance relations between the magnetic pick-up and the input of the transformer T1 are satisfied.

The correct filament voltage for the pair of 245 tubes is obtained directly from a winding on the Thordarson power compact unit. The filament supply for the 227 tube employed in the first stage of audio-frequency amplification is obtained directly from the separate filament transformer T6, which also supplies the filament voltage to the tubes employed in the tuner unit.

Grid biasing of both the first and second stages of audio amplifica-

An over-all view of the 245 power-amplifier power supply device. To the extreme left is the audio channel mounted on and under the shelf. In the center is the filter condenser and by-pass condensers. To the right is the Thordarson power compact, while to the rear is the voltage divider panel with output binding posts



POWER SUPPLY DEVICE

Tuner

By John B. Brennan, Jr.

Technical Editor

tion is obtained by means of resistors, placed in the circuits so that a sufficient voltage drop, equal to the required grid bias voltage, is obtained. In Fig. 1 resistor R6 supplies the necessary voltage drop to furnish the grid bias for the first audio amplifier tube, while the resistor R7 provides the voltage drop necessary to supply the grid bias for the two 245 tubes.

The Power Supply Device

In this installation a simple, accepted type of power supply unit is employed. It makes use of a power transformer, delivering at its secondary 300 volts either side of the mid-tap; this secondary voltage is rectified by a full-wave rectifier tube V4. From there on, the filter unit, consisting of two filter chokes and an electrolytic condenser bank of three sections, filters out the d. c. ripple so that a pure d. c. is supplied to the voltage divider. The voltage divider consisting of a number of separate wire wound resistor units is provided with

several tapped outlets so that not only are the plate voltages to the tubes in the amplifier channel supplied but also the plate voltages to tubes in the tuner unit provided.

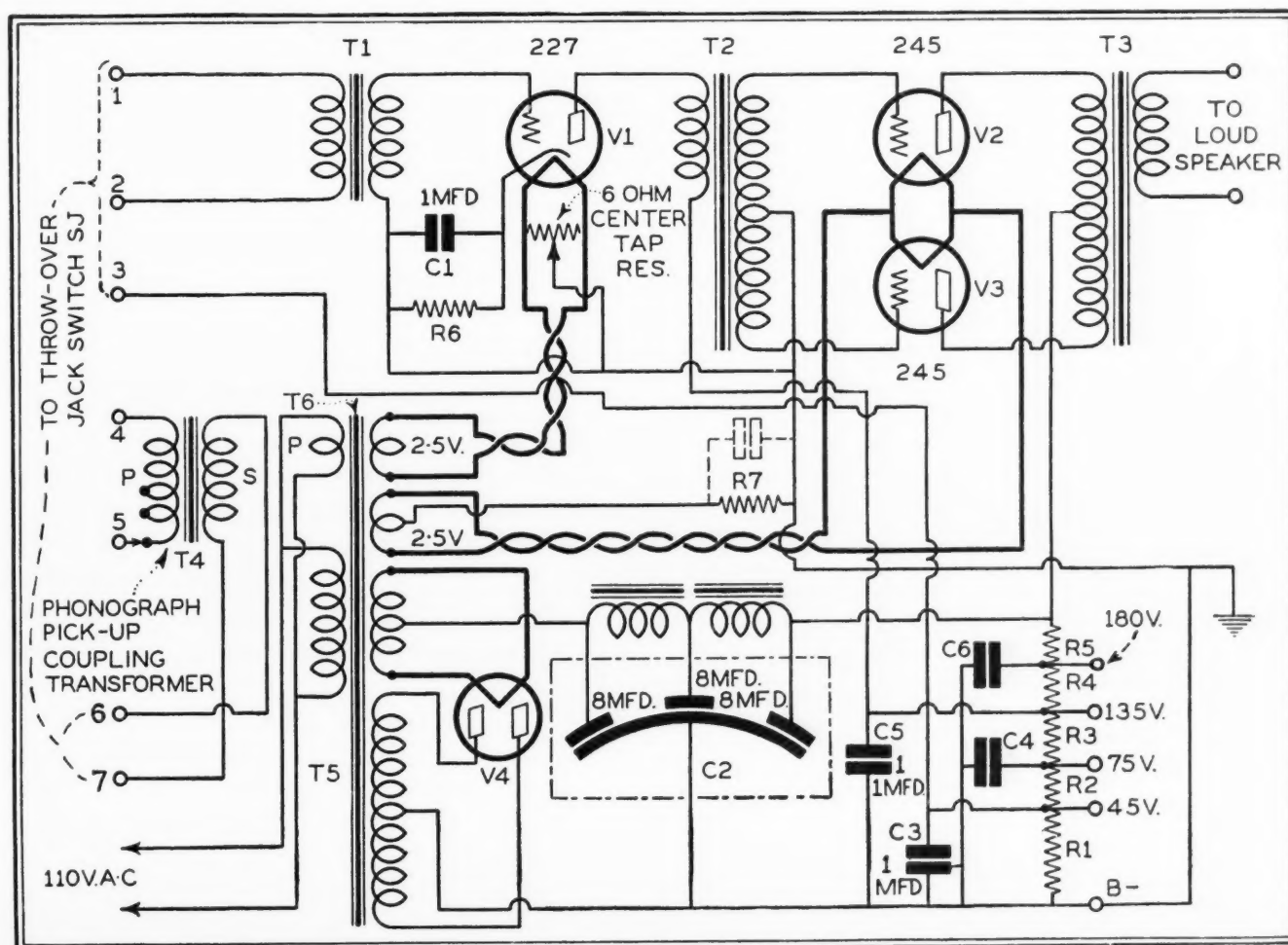
Construction

On a 1 inch board, 9 inches wide by 13½ inches long are mounted the various parts which go to make up the entire power supply and audio channel device. Reference to the parts layout, Fig. 4, will show the placement of these various units. The entire audio unit with phonograph transformer is located at the extreme right end of the baseboard. Phonograph transformer T4 and the three sockets for the three audio tubes are mounted on a shelf which is supported off the baseboard by two end pieces. The details for the construction of these end pieces are shown in Fig. 5. Underslung from

the bottom of this shelf are mounted the three transformers: the input transformer to the first audio stage, the intermediate transformer connecting the first audio stage to the push-pull power tubes and the output transformer. Details showing the construction of this shelf will be found in the accompanying photograph and sketches.

In the extreme upper left-hand corner of the baseboard is located the Thordarson power transformer, T5. Directly to its right, between it and the shelf containing the audio channel, is located the three-section Mershon electrolytic condenser unit C2, while to the front of this condenser is mounted the five filter condensers which shunt the various sections of the voltage divider. To the front of the baseboard at the extreme left is located the socket which takes the rectifier tube, V4; to its right is located the filament transformer, T6. Along the front edge of the baseboard is mounted a bakelite panel which holds the various voltage divider resistors and also the binding posts for connecting the B plus power and a.

Fig. 1. The 245's schematic circuit. Along the top is shown the audio channel, while below is the power supply circuit details



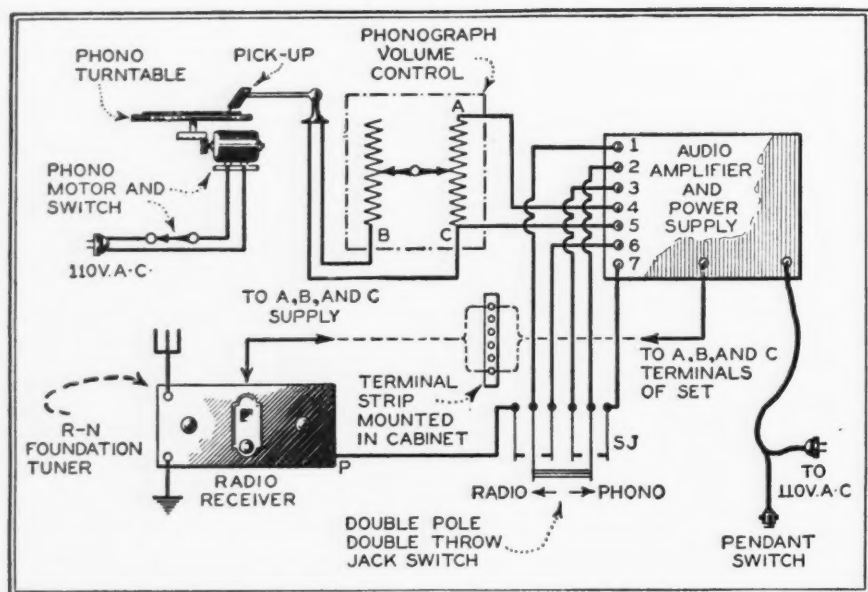
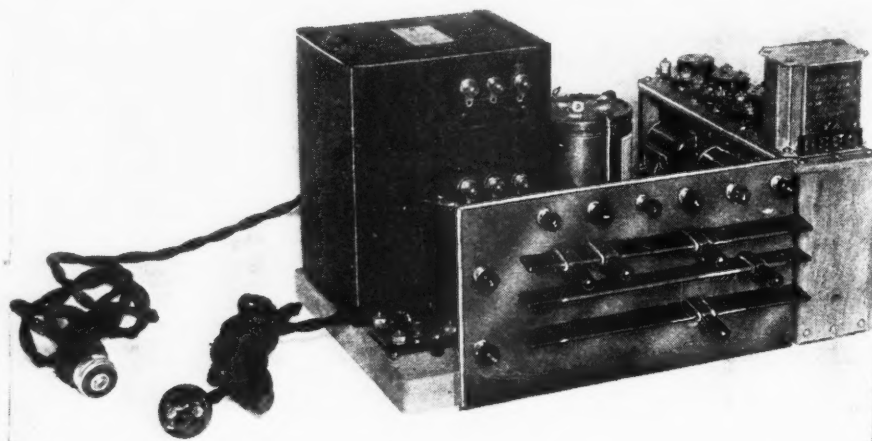


Fig. 2. To connect the amplifier-power supply device to a phonograph pickup and radio tuner the above diagram will prove helpful

c. filament leads of the tuner unit to the power supply device.

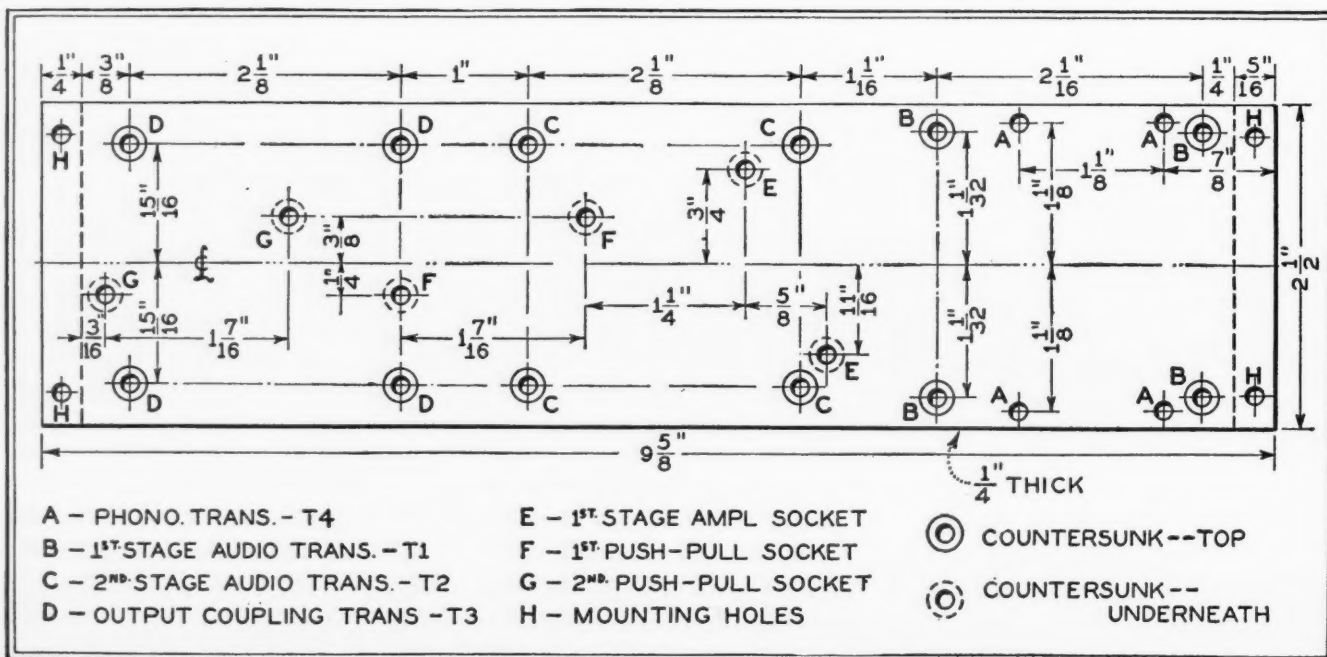
In laying out the position of the holes for mounting the socket and transformer units on the shelf, it will be necessary to follow quite closely the layout which is given in Fig. 3. It will be noted in this layout of the shelf, that some of the holes are countersunk on top while some are countersunk from the bottom. This is so that the units which mount on top will not be obstructed by the heads of the screws which hold units which are mounted from the underneath side of the shelf. Along with the layout shown in Fig. 3 is given the identification marks of the various holes, so that no trouble need be experienced in locating the various pieces of apparatus in their correct position. This shelf with its supporting end pieces may be made from some scrap pieces of bakelite or may be fashioned

from wood which may be found around the shop. It should be remembered that if the end pieces are of greater thickness than those which are indicated in the drawing, then allowance will have to be made in the overall length of the shelf so as to come flush with the surfaces of the end support pieces.



Connection to and adjustment of the plate voltage outputs for the tuner unit is made on the front panel, on which is mounted the voltage divider and output terminals

Fig. 3. In drilling the shelf to take the audio transformers, etc., follow the drilling layout below.



to pull out from their holes and make remounting of them necessary.

In the kit of Carter voltage divider resistors, which is obtained under the catalog designation of No. 2314, three resistors are provided, one of which is a plain resistor without slider tap, the second a two section resistor with two slider taps and a third having three slider taps. In the way in which this kit is used here, it is necessary, before mounting the resistors on the panel, to take one of the sliders off the second unit and place it on the first. Also, it is necessary to join together by means of a wire connection, the two sections of the second resistor strip. Arrangement of these resistors is shown in Fig. 6.

The resistors may be mounted on any scrap piece of panel (which will undoubtedly be found in the junk box) by means of small brass angle pieces readily obtainable in a hardware or 5 and 10 cent store.

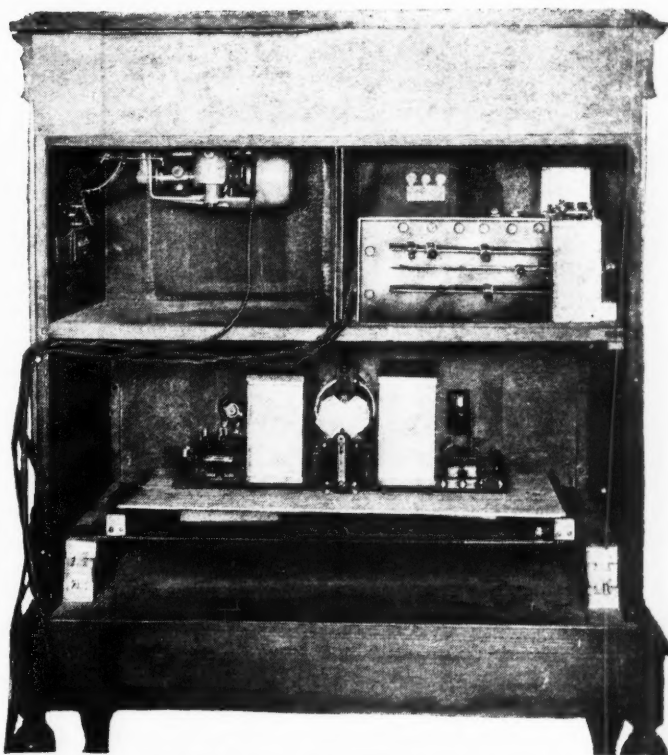
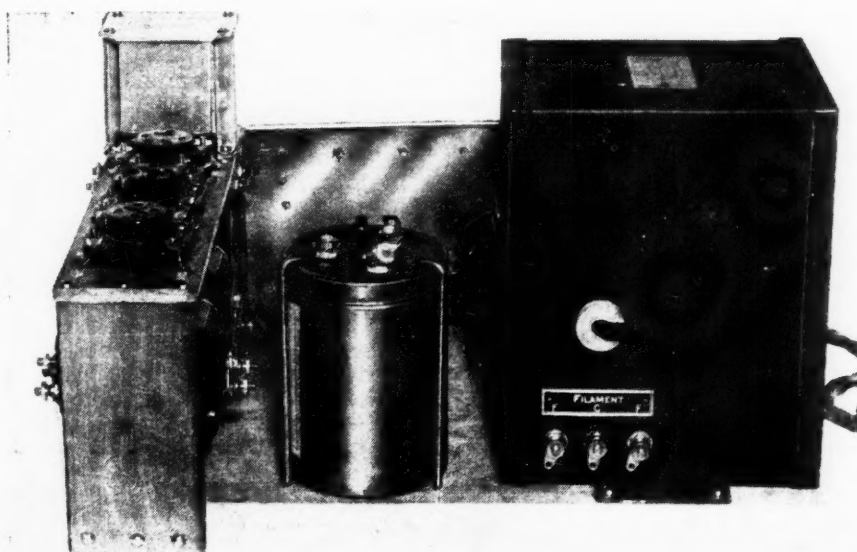
Wiring

In wiring this amplifier and power supply device there is one thing that should be kept in mind quite firmly. That is, that all of the wires which terminate at the filament posts of the various tubes should be twisted so as to minimize the possibility of the production of hum in the loud speaker. Moreover, since the current consumed by the tubes is quite high, it will be necessary to use heavier wire than is usually employed in the wiring of d. c. receivers. Wherever possible leads should be bunched together and formed into a suitable cable. In every case, the connections should be soldered so as to preclude the possibility of connections becoming loose once the unit is put into operation.

Operation

The amplifier-power supply device described here has been designed primarily to fit the space which is available in the console cabinet used. By the same token the layout of the various switches and the volume control regulator, has been made with a view to accessibility in this particular type of console cabinet and it is likely that where another type of cabinet is employed, some other arrangement will be found necessary. However, the general layout and especially the connections of the various units, one to the other, will remain the same. It is well, for instance, to have the line switch which controls the 110 volt supply to the phonograph motor mounted as near to the turntable as possible. The double-pole double-throw switch, SJ, may be mounted either on the tuner unit panel or in the "well" containing the turntable.

A rear view of the power unit. Note how the filter condenser is fastened to the base



Here is the 245 amplifier supply device housed in the console, in which is located the phonograph and R. N. Foundation tuner unit

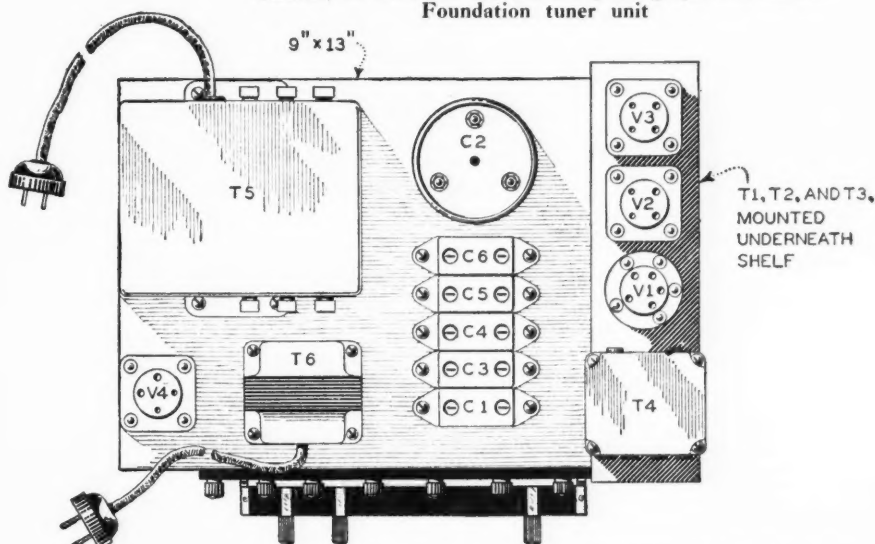


Fig. 4. The layout of all the parts which are to be mounted at the base and shelf in the above sketch. Compare it with the several phonographs accompanying

The volume control, of course, should be mounted in the same compartment which houses the turntable so that ready control of the volume from the pick-up can be obtained. Actual control of the line voltage to both the audio amplifier-power supply device and tuner unit is, of course, controlled by the pendant switch which should be connected to a cord sufficient in length to be readily accessible from the front of the console cabinet. If it is desired, another switch which connects in the filament supply to the radio tuner unit may be employed so as to control the filament supply to the tuner independently of any of the other switches. Thus, when the phonograph is in operation, it will be possible to turn

(Continued on page 381)



The Personality the Ghost

By Frances Rockefeller King

"GOOD evening, ladies and gentlemen. This is the National Broadcasting Company, New York City. We are about to present a man whose reputation is world-wide, and perhaps the best known and most widely accepted authority on psychic phenomena. . . . Joseph Dunninger. . . ."

Undoubtedly, a large proportion of the radio audience received not only this announcement, but the "Ghost Hour" which it introduced, with more than a grain of skepticism. Dunninger, seated at the microphone in the New York studio of the National Broadcasting Company, projected three thoughts over the N. B. C. network. Listeners-in were invited to try to receive this projection, and to send in their replies. The items projected by Dunninger were as follows: the name of a president (which proved to be Lincoln); a number composed of three digits (3-7-9); and a small drawing or diagram (which consisted of a small house, four windows, one door, a triangular roof, and chimney).

Over two thousand letters were sent in to the National Broadcasting Company from all parts of the country. Of these, over fifty-five per cent. had some part of the thoughts correct.

Whether we are prepared to accept

Courtesy National
Broadcasting Company

Joseph Dunninger; drawn from life by Gasparano Ricca

Below — Clipping from *The New York Telegram* telling of a typical Dunninger exploit

THE NEW YORK TELEGRAM

Joe Dunninger Shatters Peace of Ghost Seance

Friend of Harry Houdini Offers \$21,000 to Slater, Hailed by Spiritualist General Assembly as "Greatest Medium of All," for Answers to Two Questions in Sealed Envelope.

John Slater, who in the expressed belief of the General Assembly of Spiritualists, is the greatest medium of them all, had the spirits well under control last night. At the Pennsylvania Hotel they were answering the questions of any who might come along and pay his \$1, his \$1.50 or his \$2.

But Slater, who, as related by the same assembly, left home at the tender age of 30 because his family thought him crazy when he "heard voices," reckoned without an old enemy. Not Satan, whom love will overcome, but Joe Dunninger.

Houdini's Friend Pipes Up.

Joe, who used to be associated with Harry Houdini in exposing mediums, went to the seance. He paid \$1.50 and got a good seat. So did four of his friends. They listened while Slater delivered spirit messages to young and old, black and white.

Then Joe, who prefers to be called "just Dunninger," spoke up. His voice wasn't particularly gentle and he was waving his arms. The thirty-third annual spirit assembly sat up.

the Hanover Central Bank. He waved it aloft, and he waved the envelope, both with big red wax seals.

Medium Loves Calm.

It was then that the spirits almost deserted the gathering of 3,000—there was standing room only in the grand ballroom. Physical action seemed forthcoming. Slater's cohorts moved on Dunninger. Dunninger's friends stood up.

Slater, who had just been preaching the advantages of calmness and love, seemed to lose both for a moment. Dunninger left, protesting. He offered to duplicate any "spiritual" feat performed by Slater.

"It's not the game, though," he protested. "Any one who takes money to talk to spirits for you and—"

Dunninger was spluttering. "It's a valiant," he finished with a break.

Will Continue Tonight.

Slater, surrounded by admiring cohorts, had regained love and peace, however. He will continue tonight.

"And my dear people, there still

Dunninger's theory or not, we must at least admit that this large percentage of nearly correct vibrations received proves mental telepathy a possibility, and when we stop to think that over forty per cent. got the name of Lincoln right, and that over five per cent. received the entire array of thoughts correctly, the outcome of these demonstrations via radio furnishes food for thought.

Dunninger has done many things for which there seems to be no ready explanation. About a year ago, his car was stolen, and when found, was discovered wrapped around an elevated post. When the theft was reported to police headquarters, the captain laughingly requested that the owner demonstrate his ability as a mindreader by locating the car, and the thief. In this remarkable test Dunninger succeeded, and inasmuch as the knave is now serving a term in the penitentiary, having been proved guilty of this offense, it goes to illustrate that this was not a press stunt, as many believed it to be at that time.

His accomplishments and unique ability have astounded millions, yet the most marvelous feature of it all is that he is but thirty-six years of age. Never before in the history of the magical world has a man been able to climb to the top rung of the ladder of successful endeavor at so early a period in life. The late Harry Houdini, one of the greatest characters of universal show-world, had passed more than forty summers before he had earned for himself the reputation of being the world's premier mystifier in the exclusive art of handcuff manipulation, of his period. Howard Thurston, who at this time is touring the country with the largest presentation of magic and illusions, did not begin to harvest the fruit of his efforts until rather late in life. To obtain fame and fortune in the world of conjuring seems to be one of the most difficult of achievements known in the field of any of the many professions. The "Greats" of the past were all men in whose head the gray had begun to predominate, before they had earned their position as masters in their chosen fields.

Harry Kellar, Alexander Herrmann, Robert Hellar, Anderson, the Wizard of the North, and other such names that are paramount in the pages of magical history, may authentically be added to this list. Yet no man in the entire history of mystery entertainment, has earned the vast amount of publicity, and world-wide recognition, that Dunninger can boast of.

This ambitious young artist has entertained more celebrities than any other entertainer in his particular line. Among these might be mentioned the late President Theodore Roosevelt, the late President Warren G. Harding, ex-President Calvin Coolidge, and H. R. H. the Prince of Wales. Many gala society functions have programmed the appearance of Dunninger, and the smartest parties throughout the United States have been arranged with the exclusive purpose of giving the friends of the hosts an opportunity of witnessing the unique demonstration of thought transference and Indian conjuring, in which Dunninger specializes.

Dunninger has always been interested in mindreading and mental telepathy. He frankly admits that he possesses no

Behind Hour

supernatural powers, and that all of the weird things he accomplishes are but the outcome of constant study and practice. Yet, to the layman who has viewed his remarkable demonstrations, this is hard to conceive. In his school days, he could call the answer to a mathematical problem without following the usual essential routine of working out an example. When his 'phone would ring, he was often said to be able to tell who was on the other end of the wire, before lifting the receiver. Yet in spite of the fact that this odd freakish mental condition afforded him amusement, he sought to delve further into the depths of kindred mystic subjects.

He studied the arts of the East Indian wonderworker, as well as the methods of the European magicians, and, having been a great admirer of the late Harry Houdini, he was not to be outdone in this branch of the profession, and also studied the methods of self-liberation. Dunninger has among his hundreds of scrap books one in particular that he fondly treasures. This contains one hundred and sixty-five letters which have been given, after a successful challenge release, and signed by chiefs of police and prison officials in various parts of the globe.

Dunninger would enter the warden's office and defy him and his aides to place him in a cell from which he could not liberate himself. He would be stripped of his clothing, thoroughly examined, and after being securely shackled and handcuffed, would soon find himself locked behind the bars of one of those dismal cages of confinement. As a rule, it would take this young wizard but two or three minutes before he would again re-enter the warden's office, fully dressed, and holding the opened shackles in his hand. Escaping from packing boxes, water filled



Courtesy National Broadcasting Company

Artist Ricca's impressions of a mind reading demonstration

tanks, straitjackets, etc., was also part of Dunninger's routine, and although he soon discarded this work from his repertoire, he still possesses one of the largest collections of restraint implements and handcuffs in the world. The pillories, antique irons, and special devices used as far back as the Spanish Inquisition are included in his collection that numbers into the thousands.

His knowledge of the magicians' art has also been attained by practical experience, judging from the fact that at the present time he has over three hundred illusions in his storehouse, many of which have been used by famous magicians, past and present.

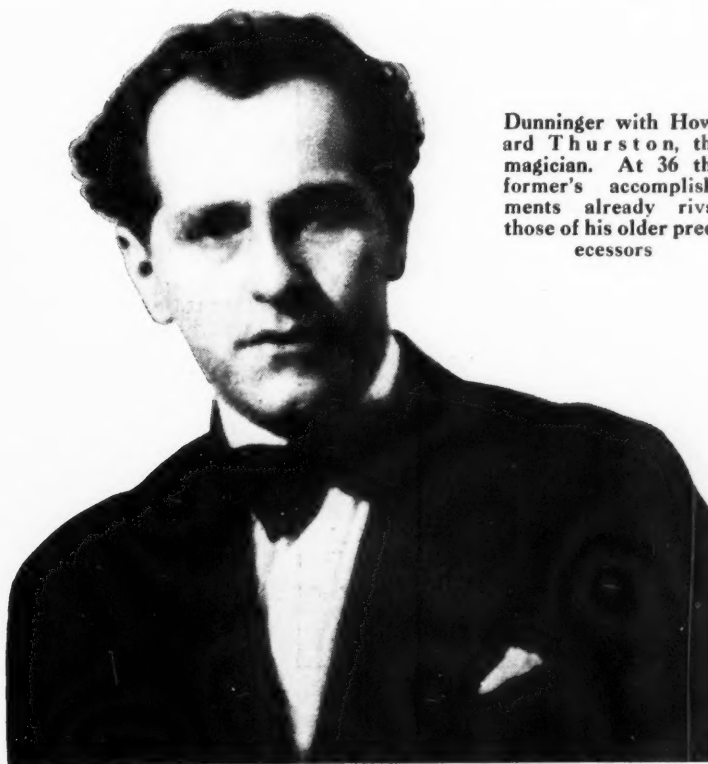
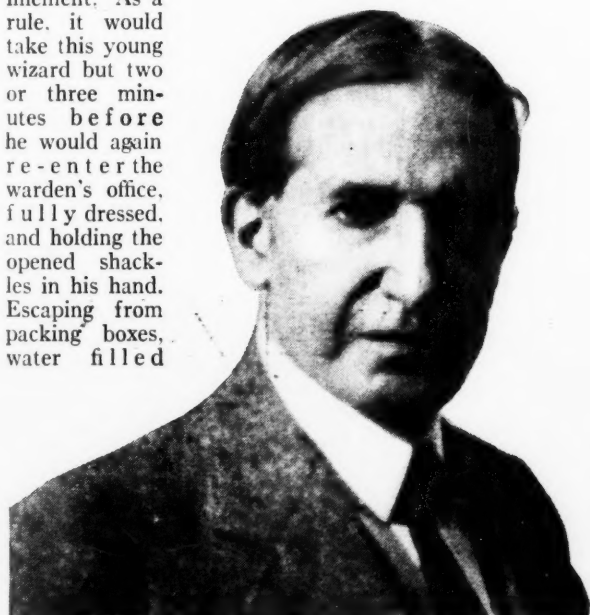
In this collection is one particular

effect that is known the world over. This is called the Automaton Psycho. Many years ago this illusion was purchased by the late Harry Kellar, from Maskelyne and Devant in England. It changed hands, and became the property of Charles Carter, Howard Thurston, back again to Kellar, and then to the late Harry Houdini.

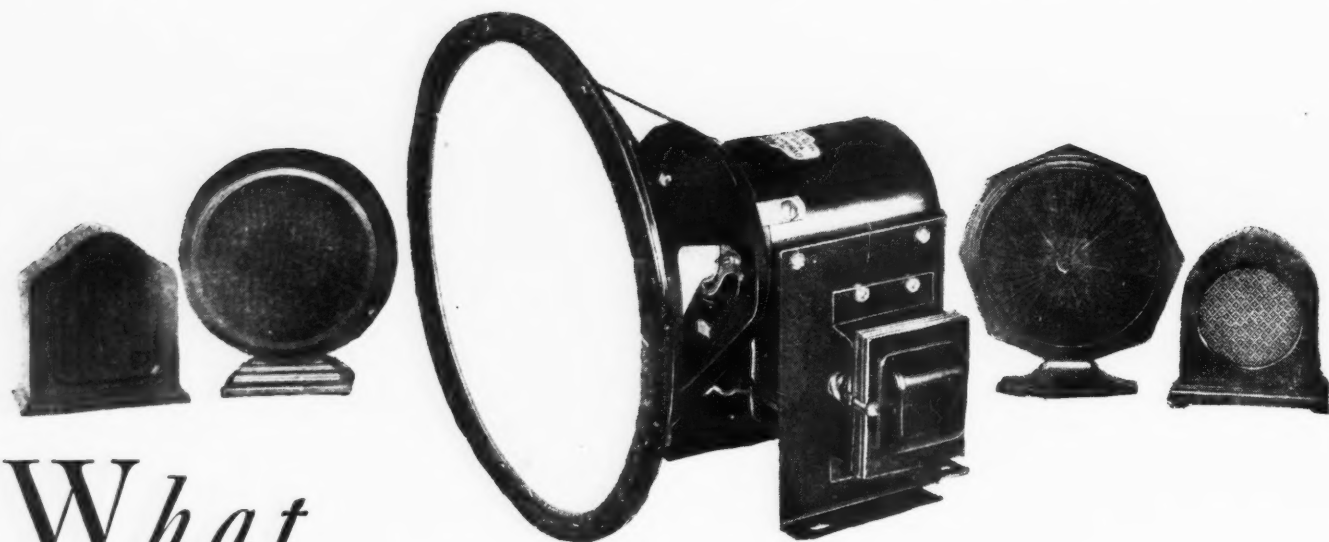
Dunninger offered Houdini \$1,500 for this effect, but was smilingly refused; yet when the latter died, his friend was agreeably surprised to find that Houdini had made provision so that Psycho would be passed on to him.

Psycho consists of a small Arabian figure, which rests upon a glass cylinder.

(Continued on page 358)



Dunninger with Howard Thurston, the magician. At 36 the former's accomplishments already rival those of his older predecessors



What Is A GOOD Loud Speaker?

A Discussion of the General Types of Reproducers With Special Treatment of the Dynamic

By James Martin

THE loud speaker is but one link in the chain that connects the broadcasting station with the listener in his home. It is no more—or less—important than any of the other links. In the radio chain between the artist's voice and our own ears there are microphones, transformers, wire lines, the ether, a loud speaker, batteries and tubes; defects in any one of them can ruin a program. Considering all the

possibilities for distortion, the excellent quality that a good radio installation can supply is really remarkable. It is indeed fortunate that, unlike a woman, electrical apparatus is not fickle. Once put in good condition it will with ordinary care remain in such condition for a long time (referring of course, to the electrical apparatus and not the woman.)

Most of the larger broadcasting stations transmit excellent quality signals. There is no reason why every experimenter with a good tuner and a good audio amplifier should not be able to listen to excellent reproduction—provided of course that he has equipped his set with a good loud speaker—one that is capable of reproducing most of the audio frequencies with uniformity and without any serious distortion. Of all the links in our chain it is probable that, generally speaking, the loud speaker is the weakest. For this, if for no other reason, the greatest of care must be exercised in its selection. Because the loud speaker is so important we have devoted this article to a discussion of it, pointing out what requirements it must meet and something of how to judge loud speakers with the hope that it will perhaps help the home constructor and experimenter to obtain maximum enjoyment from his hobby—radio.

In the first place, what is a loud speaker? It is a machine. And its function is to take the electrical energy which it obtains from the radio receiver and convert this energy into sound. This it does through the medium of the diaphragm which, vibrating in the air in accordance with the variations in the electric currents passing through the coils, produces variations in air pressure. When

these variations in pressure strike our ears they cause small membranes in our ears to move and we hear a sound.

The Perfect Loud Speaker

What would be the characteristics of a perfect loud speaker? In the first place, a perfect loud speaker would reproduce all the frequencies over the entire audio-frequency band which extends from say 15 cycles up to about 12,000 to 14,000 cycles. It would reproduce all these fre-

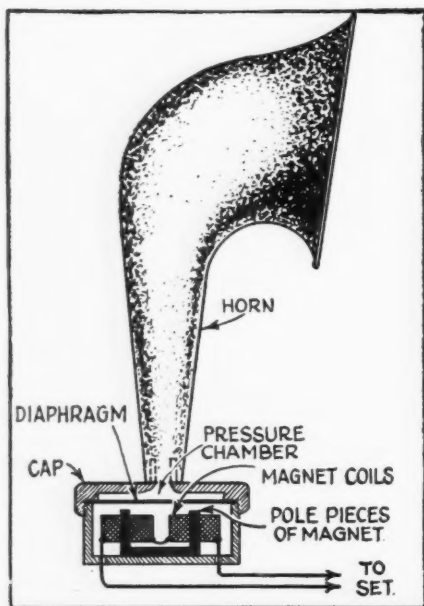


Fig. 1. The first types of loud speakers were nothing more or less than a phone unit with horn attached to amplify the sound

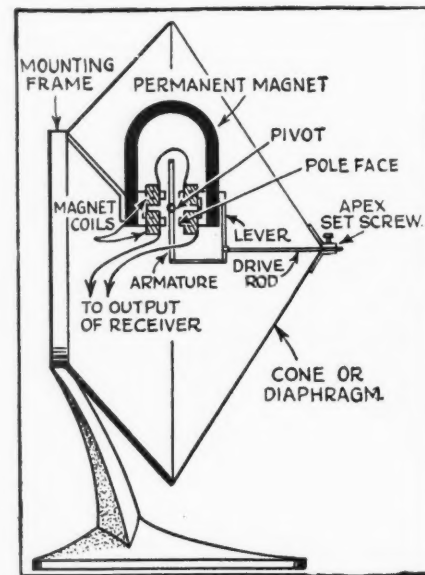
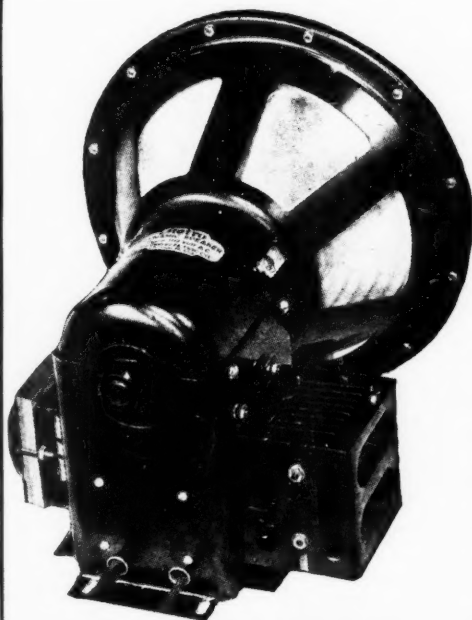


Fig. 2. Cone loud speakers employ in general a driving mechanism similar to that shown here. The entire cone acts as a diaphragm

quencies without discrimination, in other words a response curve of its performance would be "flat" over the entire band. The perfect loud speaker would introduce no new frequencies; that is, if supplied with a pure 60-cycle current it would produce a pure 60-cycle note and not a complicated tone consisting of some 60 cycles and also some of the harmonics of 60 cycles. It would be capable of handling the maximum desired volume without distortion due to overloading or rattling. It would be efficient, converting all or nearly all of the electrical energy supplied to it into sound. It would have a very long useful life and be not in the least affected by dampness or other atmospheric conditions. Does anyone know of a loud speaker that meets all of these requirements? I don't.

Fortunately the loud speaker we use doesn't have to be absolutely perfect to produce very good results and make listening to radio an enjoyable pastime. The problem is how far the practical loud speaker can depart from the ideal and still be satisfactory. The range of audio frequencies extends, as previously indicated, from about 15 to 14,000 cycles, but the problem is to decide how many of the low frequencies can be eliminated before serious distortion results. Competent authorities feel that essentially perfect reproduction can be obtained in the frequency band between 30 and 10,000 cycles, the elimination of all frequencies above and below these limits causing no noticeable change in quality. Further it has been found that cutting the frequency band from 10,000 down to 6,000 or 7,000 cycles produces but a very slight change in quality—a change that can only be detected by a direct comparison between the original and the reproduction.

As a result of many practical tests it has also been found that a variation of three to one in the response characteristic is practically negligible and the variations of five to one are not especially important.



A dynamic speaker, showing coupling transformer and dry rectifier

Practical tests have also shown that a distortion of five percent is also not noticeable. A practical loud speaker can be quite inefficient, for the efficiency does not effect the quality and simply necessitates that we must supply the loud speaker with more power for a given volume of sound. Present day loud speakers are characterized by very low efficiencies. Probably the best of loud speakers are one or two percent efficient; that is for very 100 units of electrical energy supplied to them they only produce 2 units of sound. If loud speakers could be made ten times as efficient as at present probably we could all throw away our power tubes!

In summary therefore we can say that a loud speaker, to be "practically" perfect should reproduce the band of audio frequencies between 30 and 6,000 cycles, that the amplitude distortion should not be greater than about three to one, that the harmonic distortion should not be

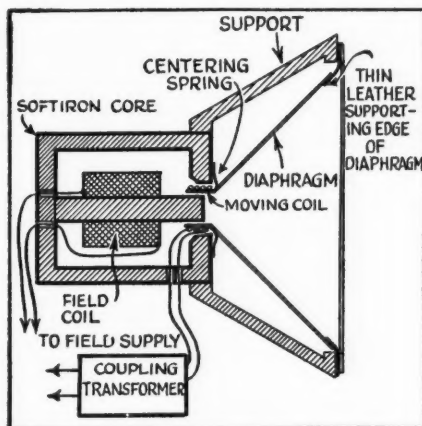


Fig. 3. Herewith is shown the general arrangement of the various parts of a dynamic speaker. Compare it with that shown below

greater than about five per cent and that, although high efficiencies are desirable, quite low values of efficiency are not especially disadvantageous since sufficient power to make up for the low efficiency can easily be obtained from ordinary power tubes.

Several Types of Speakers Now in General Use

Loud speakers have been made using a large variety of principles but most of them have proven impractical for one reason or another. All loud speakers in use today (with the exception of the condenser loud speaker) depend for their operation on magnetic forces. The three types of loud speakers now in general use are the horns, Fig. 1, cones using balanced armatures, Fig. 2, and dynamic loud speakers, Fig. 3, which are cones driven by a moving coil. The two former types, *i. e.* horns and ordinary cones, have definite limitations. Horns, unless they are of the exponential type and very large are definitely limited in frequency response. A newcomer in the loud speaker field is the condenser speaker of which more will be heard of in a following article.

Probably the outstanding example of a good balanced armature type loud speaker



To give the cone of this dynamic a degree of rigidity, it is serrated, as shown in the battery-operated dynamic above

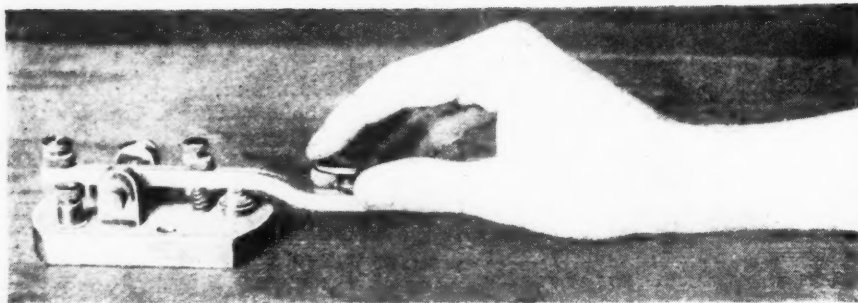
is the Western Electric cones, types 540 and 560. These loud speakers, especially the 540 and similar cones made by other manufacturers, were exceedingly popular and have experienced competition only lately by the introduction of the dynamic type loud speaker. The balanced armature type of loud speaker drive is arranged as indicated in Fig. 2. It consists of a permanent magnet, M, with four pole faces arranged adjacent to the armature. The armature is balanced between the pole pieces and around the armature is wound the coil which is connected to the radio set. The audio-frequency currents from the output of the set, passing through the coil, caused it to move in the space between the pole pieces. In so moving it of course carried the diaphragm with it and the movements of the diaphragm produce a movement of an air column thus causing the sound. Well designed balanced armature type loud speakers are capable of giving quite excellent results although they have several quite definite defects, among which are magnetic saturation, limited movement, resonance in the armature and driving pin, varying impedance characteristic, etc., and these are sufficient to definitely limit the results obtainable from this type of loud speaker. The better cones of the last two or three years were probably as good as could possibly be obtained consistent with reasonable cost. In a certain sense therefore the dynamic loud speaker was forced into existence because of the limitations of other loud speakers—the art had to advance and in the case of loud speakers some fundamental change was necessary to permit this advance.

The dynamic speaker, with which this article will mainly concern itself, works on principles quite different from those found in the balanced armature type although in both cases magnetic forces are involved. Because the dynamic loud speaker is rapidly replacing both the horn and the ordinary cone, being capable of giving much better results than either of these types, we will devote considerable space to an examination of the design of dynamic loud speakers. After all a loud speaker, even the best, is simply a number of pieces of metal, paper, fibre and wire and it is useful to know how these

(Continued on page 368)

Breaking into AMATEUR TRANSMITTING

By Lieut. William H. Wenstrom, U. S. A.



LAST month we traced at some length the absorbing story of Amateur Radio; we now consider some of the practical problems which confront an entrant into the transmitting fraternity. First of all, let us forget any lingering hostility which we may feel towards code—the dot and dash signals of radio telegraph stations. Once fairly learned, code is not at all the stupid, meaningless collection of symbols that it appears to outsiders. Ruling out machine and “bug” sending, an unbelievable amount of personality trickles through the sending of an individual, however measured he may strive to make it. We can easily classify experts and dubs—can even recognize quickly an operator with whom we have talked before. No two humans are exactly alike, and tricks of spacing and tempo mark an individual as surely as his manner of

parting his hair. Strange as it may seem, it is almost as hard to keep the emotions out of code as out of the voice; timidity and anger both have their dot-dash rhythms.

Manners and consideration for others, or the lack of them, are as evident on the air as they are on the road. We have all blessed the driver who put out his hand a few seconds before he turned, or realized our momentum along a highway well enough to refrain from crawling out of a side street directly in front of us. And we have all cursed the man who turned directly in front of us with little if any warning, or passed us in a burst of speed only to slow down immediately. The latter individual's counterpart on the air is characterized by a sputtering, wobbly note, too-rapid and unintelligible sending, and scarcely anything to say except “hows mi sigs? rpt my sig strength—pse send card—cul gb.” When we come back with “hr msg air transport emergency,” he greets us with a profound silence only to be broken by a sputtering “cq” for somebody else. But this type

is fortunately a very small minority—else all cars would be wrecked and all transmitters gathering cobwebs. By means of abbreviations two good operators can talk in code almost as fast as they could by telephone. The system is a sort of home-made shorthand wherein unnecessary letters, particularly vowels, are omitted. Weather is wx, press is px, repeat is rpt, thanks is tx or tks, your is ur, very is vy, please is pse; and so on, ad libitum.

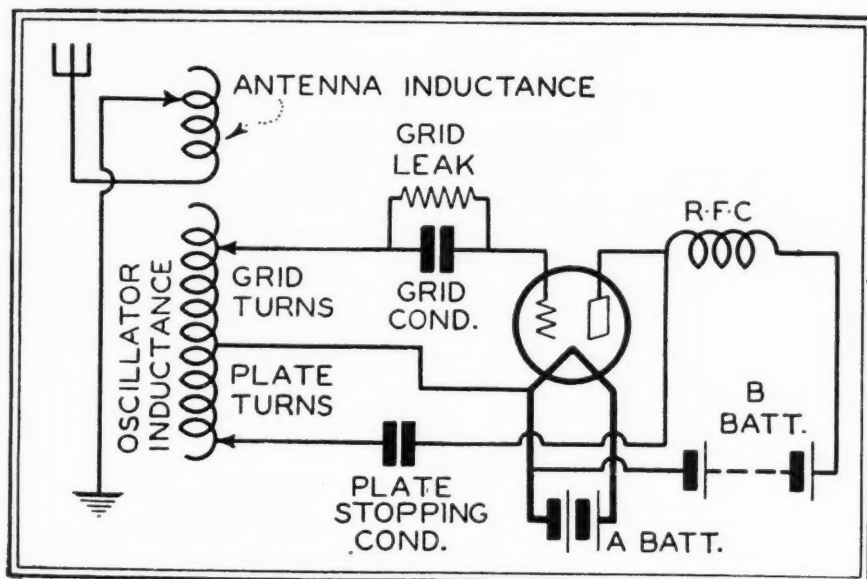
Another distinctive pleasure of transmitting is that two-way communication requires far more skill than receiving. When skill entails work, distasteful to many of us, this statement may seem rather paradoxical; nevertheless, it is a fact, amply proved by observation. The devotees of chess would scarcely consider checkers; a hunting horseman has no taste for ambulating through the park on a tame nag; good sailormen would be bored to death on a motorboat. The transmitting operator has not only his receiver to think of; the transmitter must be turned on and adjusted for frequency, output, efficiency and steadiness. The wily distant station must be sought among the channels like an elusive deer in the forest, and when it is found, no hunter's trigger finger could be more smoothly certain than the hand that throws the switches and taps the key.

Another advantage of transmitting is greater control over the phenomena, to borrow a phrase from the laboratory. Reception is likely to degenerate at times into a sort of watchful waiting, but the owner of a transmitter can always start something. A well-remembered incident at W2CX occurred during the ill-fated Atlantic flight of Nungesser and Coli. W2CX hopped into the well filled 40 meter conversational puddle with a long CQ and “Any news of Atlantic fliers?” This innocent inquiry was apparently interpreted as a statement preceding the broadcast of important news, for immediately half the stations in New York and New England were heard frantically calling W2CX.

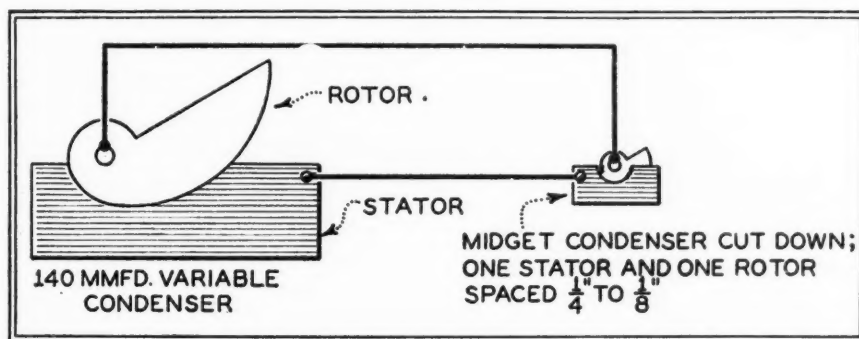
Then, too, phone receiving is somewhat limited in its scope, for broadcast transmitters have a tendency to congregate around the large cities of the world. They seldom go to sea, or essay the air, or take themselves off into remote jungles. But the amateur and experimental code sta-

The Department of Commerce of the U. S. Government issues to all who satisfactorily pass the required tests a license similar to Lieut. Wenstrom's, shown here





tions are everywhere. Another W2CX red letter occasion was an evening chat with a courteous Englishman up in Cameroons, French Equatorial Africa.



It consisted mostly of questions from New York and answers from Cameroons. "Are you on the coast or up in the jungle?—a bout 100 miles from coast. Is it pretty hot there?—very warm all year round. Are there any lions around there?—lots of game here, both big and small."

If the answer had been "there is a big lion looking in the window and roaring now," we would probably have believed it.

Atlantic flights and roaring lions are all very well in their way, but let us get down to business. Several weeks at least before he starts actual transmitting the new operator should have completed the installation of a short wave receiver, both for code practice and for familiarity with the various amateur bands. Just what kind of receiver this is does not particularly matter, so long as it meets certain fundamental requirements. The first of these is ability to go smoothly into and out of oscillation at any frequency within the receiver's range. (A grid biasing potentiometer, as used in the Portable Receiver described in the July issue, is useful here.) Secondly, the amateur band corresponding to any particular coil should be well spread out along the center of the tuning dial. The extreme fulfillment of this requirement is the "traffic tuner" which spreads a single amateur band over the whole dial. Somewhat the same delicacy of tuning with better all around coverage may be gained by connecting a midget condenser (cut down to one stator and one rotor)

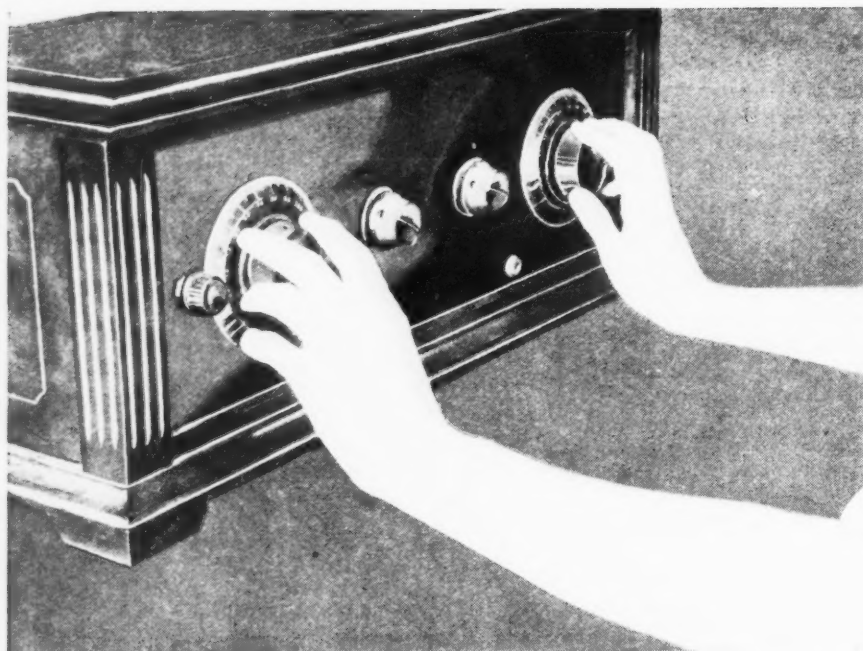
in parallel with the regular tuning condenser of about 140 m. m. f., as shown in Fig. 1. Another requirement is the ability to change wave-bands quickly, and still another is some form of arm rest for tuning, as shown in the photograph. Distant high frequency stations cannot be snapped in with the casual dial

with a long outdoor antenna) if no extra tuning controls are added. For searching a band quickly the receiver must be strictly single control (have only one tuned circuit). This does not include the oscillation control, which requires only occasional adjustment.

There are now so many good short wave receivers available that anyone may easily buy or build one. The four commercials—Silver-Marshall, National, Pilot, and Aero—are well designed and dependable. Then there is Samuel Egert's "S-W Four" described in the August issue, of which the detector unit and one audio stage would do very well for amateur work. A general discussion of 1929 amateur receiving requirements appeared in QST for November, 1928. For anyone who wants the utmost simplicity and ease of construction combined with creditable performance, the writer's "Cornet Receiver" described in Radio Broadcast for April, 1928, should prove useful. This set is still in use at W2CX, for nothing in the way of all-around code and phone performance by any newer design has inclined us to discard it.

Code Practice

The greatest bugbear in the way of becoming an operator is undoubtedly mastering the code. There is no absolutely



A firm, substantial rest for the forearm is an absolute necessity for distance tuning

Your station license, when issued, will authorize you to begin your transmitting career

THE GENERAL SERVICE CODE

A dit dah
 B dah dit dit dit
 C dah dit dah dit
 E dit
 F dit dit dah dit
 G dah dah dit
 H dit dit dit dit
 I dit dit
 J dit dah dah dah
 K dah dit dah
 L dit dah dit dit
 M dah dah
 N dah dit
 O dah dah dah
 P dit dah dah dit
 Q dah dah dit dah
 R dit dah dit
 S dit dit dit
 T dah
 U dit dit dah
 V dit dit dit dah
 W dit dah dah
 X dah dit dit dah
 Y dah dit dah dah
 Z dah dah dit dit
 1 dit dah dah dah dah
 2 dit dit dah dah dah
 3 dit dit dit dah dah
 4 dit dit dit dit dah
 5 dit dit dit dit dit
 6 dah dit dit dit dit
 7 dah dah dit dit dit
 8 dah dah dah dit dit
 9 dah dah dah dah dit

Time or duration relations:
 dah is three times as long as dit

intra-letter space same length as dit
 inter-letter space same length as dah
 inter-word space two or three times as long as dah

painless way of learning it, or of doing anything else which requires mental effort and concentration. But the process will be easier if two cardinal principles are borne in mind. First, learn each letter as a single unit of sound, rather than as an aggregation of dots and dashes; second, do not hesitate over missed letters but go on to the next. It is much simpler, for example, to write "x" instantly when we hear a "Dah-dit-dit-dah" sound, than to think "dah-dit-dit-dah—let's see, that's dash-dot-dot-dash, and as I remember it, x looked about like that." Therefore eliminate any visual images of "x," such as — · · ·; the jump from ear to fingers is naturally much quicker than dragging in the visual part of the brain as well. Until you can write down each letter reasonably soon after the sound is heard, it is advisable to have someone send slowly to you on a buzzer, or to use a teleplex or omnigraph. After your speed begins to pick up a little, the short wave receiver offers a more varied and interesting field for practice. It is usually possible to find in one of the bands an amateur sending at a speed you can copy, and sometimes the highpower commercials are slowed down as low as ten words a minute under poor transmission conditions. Along with reception it is well to practice keying. As shown in the photo-

(Continued on page 364)

Form No. 5-A

File No. 1. M
 Official No. 2693
 Call Letters W 2 C X

UNITED STATES OF AMERICA FEDERAL RADIO COMMISSION

AMATEUR RADIO STATION LICENSE

Subject to the provisions of the Radio Act of 1927, as amended, subsequent acts, and orders, and all regulations hereafter made by this Commission, and further subject to the conditions set forth in this license.

LICENSEE William Holmes Wenstrom

is hereby authorized to use and operate the radio transmitting apparatus hereafter described for the following purposes for the term beginning June 12th, 1929, and ending June 11th, 1930, unless this license is sooner suspended or revoked.

This license shall not vest in the licensee any right to operate the station or any right in the use of the frequencies designated in the license beyond the term hereof, nor in any other manner than authorized herein. Neither the license nor the right granted hereunder shall be assigned or otherwise transferred in violation of the Radio Act of 1927, as amended. This license is subject to the right of the Government of the United States conferred by Section 6 of the Radio Act of 1927.

The licensee is authorized to use and operate the apparatus located at No. 1, S. S. Military Academy, City or town of West Point, County of Orange, in the State of New York, described as follows:

Transmitting Type

Licensee is authorized to communicate only with similarly licensed stations and on frequencies within the following bands:

Kilocycles	Kilocycles
1,715 to 2,000	28,000 to 30,000
3,500 to 4,000	56,000 to 60,000
7,000 to 7,300	400,000 to 450,000
14,000 to 14,400	

Amateur radio telephone operation is authorized only on frequencies within the following bands:

Kilocycles
1,715 to 2,000
3,500 to 3,550
56,000 to 60,000

Amateur television and operation of picture transmission apparatus is authorized only on frequencies within the following bands:

Kilocycles
1,715 to 2,000
56,000 to 60,000

Licensee is authorized to use a maximum power input into the final stage of the transmitter, and to operate at all times, unless interference with other radio services is caused, in which event a silent period must be observed between the hours of 8:00 p. m. and 10:20 p. m., local standard time, and on Sundays during local church services.

The frequency of the waves emitted must be as constant and as free from harmonics as the state of the art permits. The station operator must announce call letters and location as frequently as may be practicable when station is in operation, and in any event not less than once during each fifteen minutes of transmission. This requirement is waived when such announcement would interrupt a single consecutive message, and in such cases the announcement of the call letters and location shall be made at the beginning and end of such message.

Licensee is not authorized to use damped waves nor is licensee authorized to broadcast news, music, lectures, sermons, or any other form of entertainment, or to conduct any form of commercial correspondence.

Dated this 12th day

of June, 1929

At New York, N. Y.

FEDERAL RADIO COMMISSION,

IRA E. ROBINSON,

Chairman.

CMF

By

Supervisor of Radio.

The Tube Industry Becomes BIG BUSINESS

By William F. Matthews

ALMOST over night the tube-making part of the radio industry has emerged from a state of comparative uncertainty to become one of the most stable and promising divisions of the whole enterprise.

With starting suddenness radio broadcasting swept over the land and set up a constantly growing demand for tubes. With the electric light bulb industry to offer a basis for manufacture, the infant tube industry got away to a flying start. Now catching up with demand, then running ahead of it; beset with innumerable manufacturing difficulties and the pitfalls caused by an impatient public; remedying its faults as it went along and uncovering still more secrets locked in the depths of refinement—these and many other influences presented themselves for the industry to hurdle. From the laboratory in a small bedroom to the mammoth tube manufacturing plants of today with untold millions of capital invested; from nothing at all to sales approaching \$150,000,000 annually with many more millions in sight—that, my friends, constitutes the swift growth of the radio tube business, in but a few years.

There are at present more than fifty manufacturers engaged in making radio tubes. The products of the majority of these manufacturers are really high-grade, although those enjoying the best of re-

search facilities and the capital to put refinements into production naturally are in a better position to turn out better products. And yet some of the most notable advances in tube construction and performance have emanated from the laboratories of manufacturers not so favorably situated. Genius follows no prescribed nor dictated path.

The capitalizations of these tube companies range all the way from a few thousand dollars to many millions. The majority of the companies are closely held, having been financed by a few individuals. Several, however, enjoy listing on various stock exchanges and thus serve as an index of the business. Moreover, a surprisingly large number of the tube companies, both publicly held and otherwise, are making money. The income from tubes constitutes the bulk of the earnings of the Radio Corporation of America, although no definite figures are available. Many of the so-called independents, such as Ceco, Triad, Sonatron, Sylvania, Gold Seal, Marvin, Arcturus, Van Horne and a host of others, derive their sole income from the sale of tubes and many of them are in a flourishing and expanding condition. Conceivably, tube manufacturing may be overdone, and yet it may be several years before retrenchment will set in. That the industry is bound to go through successive corrective stages no one, save possibly an

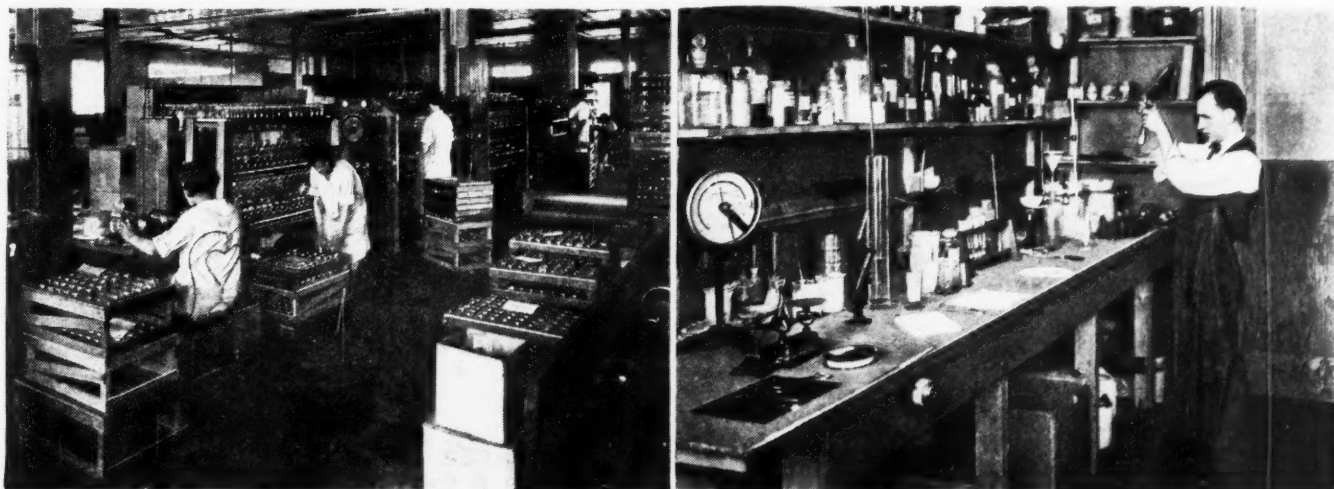
over-enthusiastic manufacturer, will deny; and then he will most likely pay the penalty of his enthusiasm.

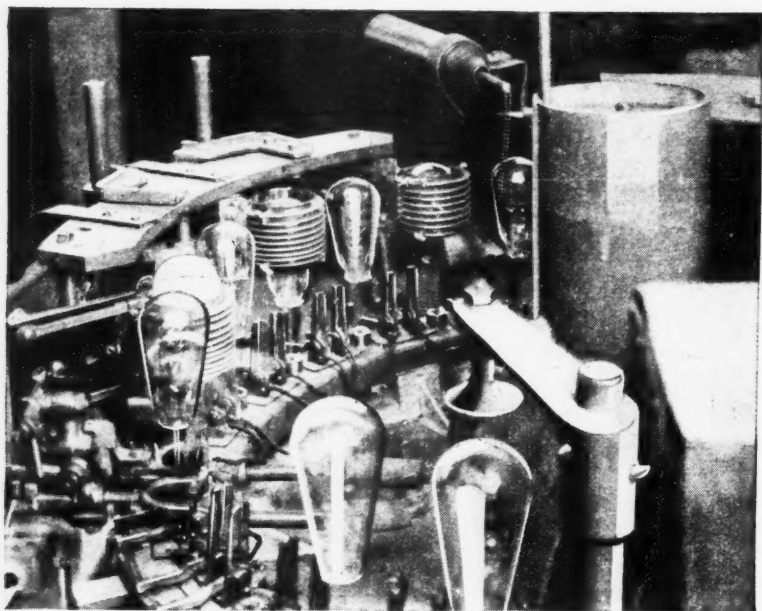
Where Is the Saturation Point?

According to figures compiled by the Department of Commerce, the saturation point in radio is far, far away. It has been estimated that only one-third of the homes throughout the United States possess radio receiving equipment, and throughout the world the percentage is exceptionally small. Add to this the fact that the world never yet has caught up to the mythical saturation point on any product that is good.

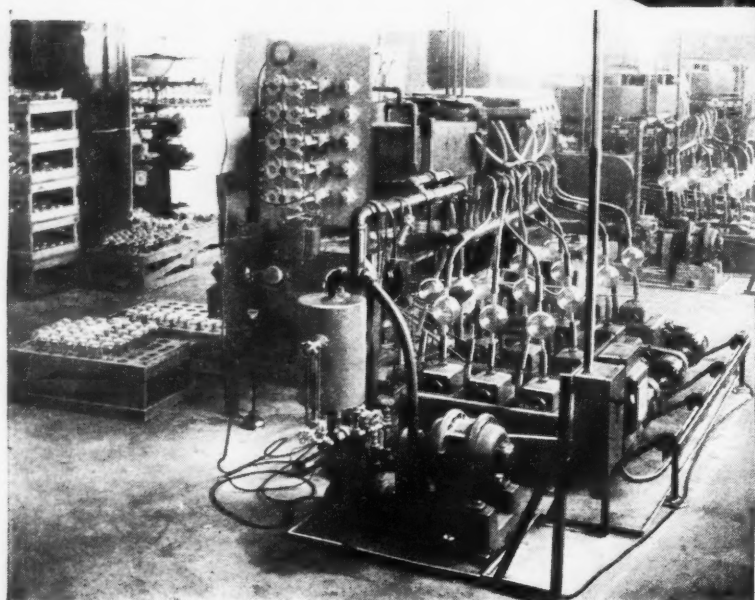
To begin with, we had a radio tube. Now we have radio tubes. In the early days of the radio novelty era, any screech or howl that came through the loud "squeaker" sufficed. Then began the quest for quality coupled with sensitivity. Tubes influenced radio design and quality of condensers, transformers and such like influenced the output of tubes, and the whole was dependent on what the loud speaker was willing or able to interpret. Radio reception was faced with a whole array of handicaps, the principal one of which was the inflexibility or the inability of the radio tube to work satisfactorily as a radio frequency, intermediate frequency or audio frequency amplifier and rectify the incoming signals as well. And so the problems of designing suitable tubes for

Courtesy Cable Radio Tube Corporation



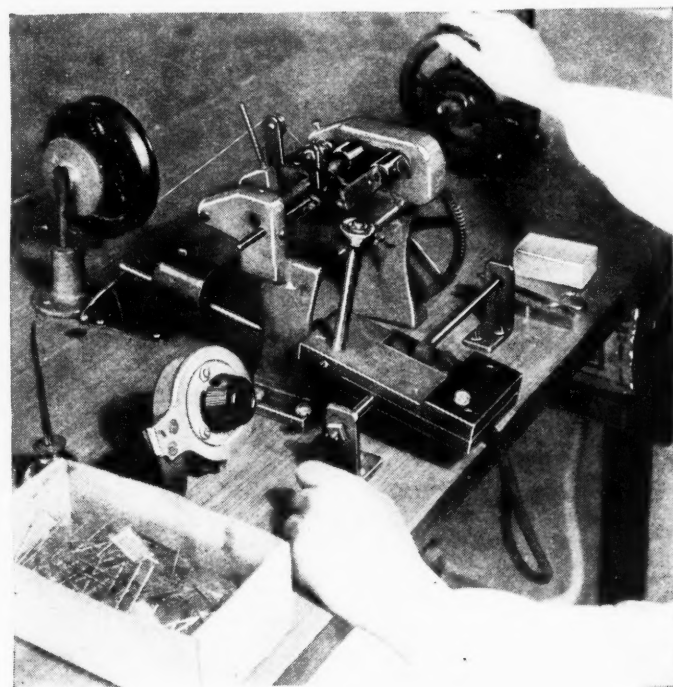
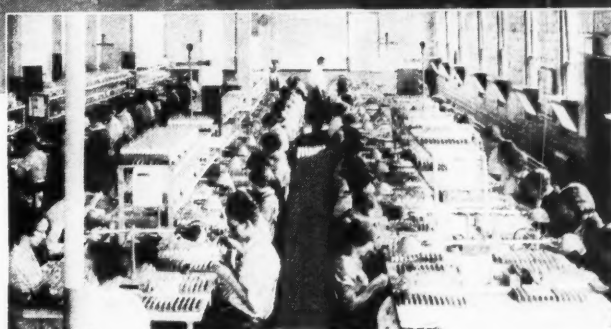
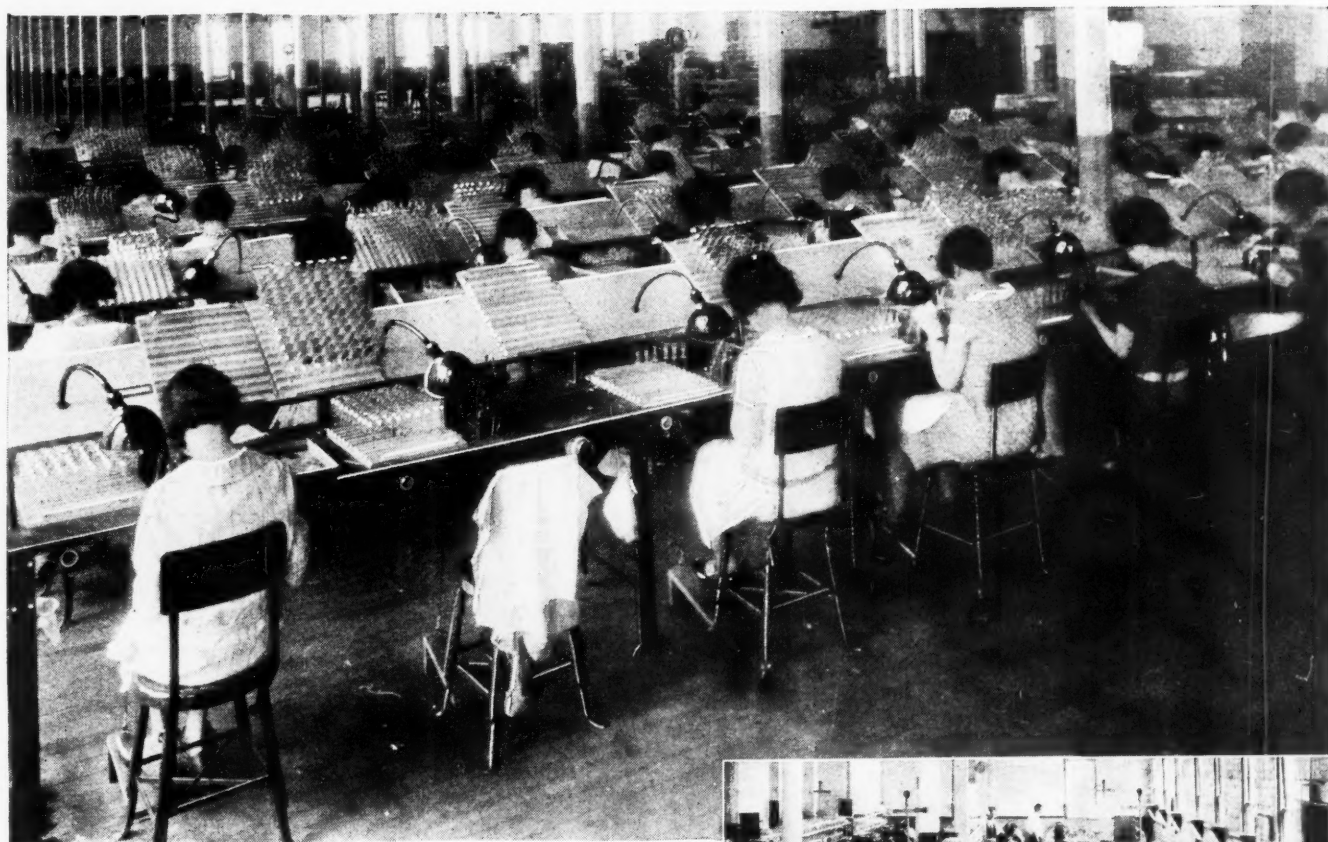


Photographs on these two pages by courtesy of Sylvania Products Co., Duovac Radio Tube Corp., Triad Mfg. Co., Inc., Ceco Mfg. Co., Inc., R. C. A., National Carbon Co., Cable Radio Tube Corporation

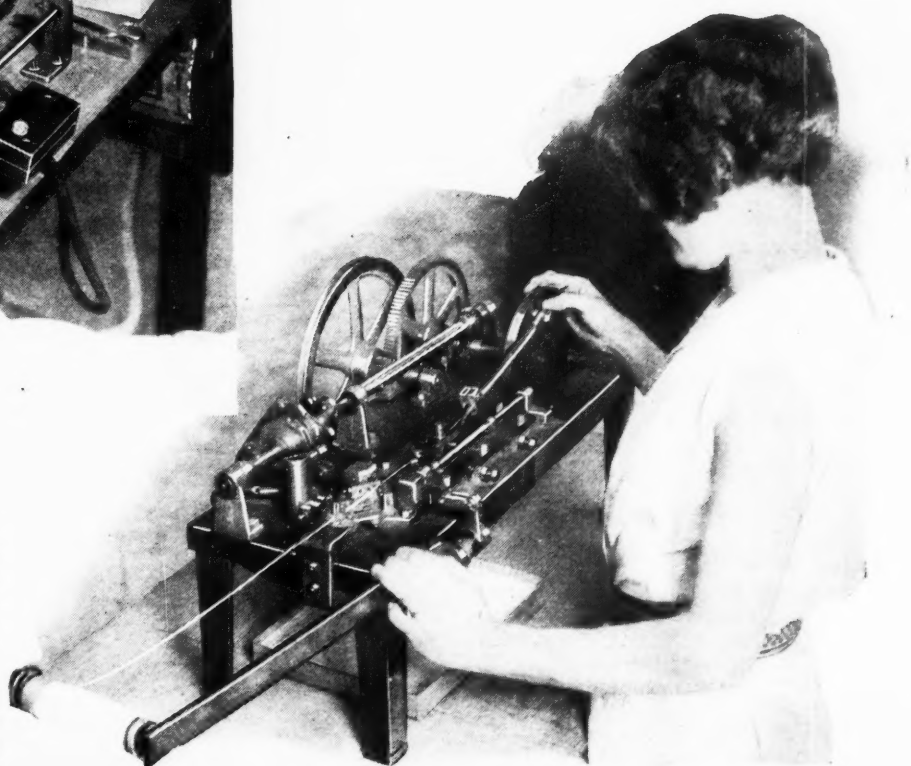


each position in a receiver got definitely under way. That marked the beginning of a financially successful day for radio.

Note what happened to the tube sales in 1928, the year that saw the introduction (in volume) of the a. c. tubes. Sales jumped nearly double over 1927 (from \$67,000,000 to about \$112,000,000) and the full buying power of the public, as measured from the standpoint of the replacement of battery-operated tubes with the a. c. types, had, at the end of 1928,



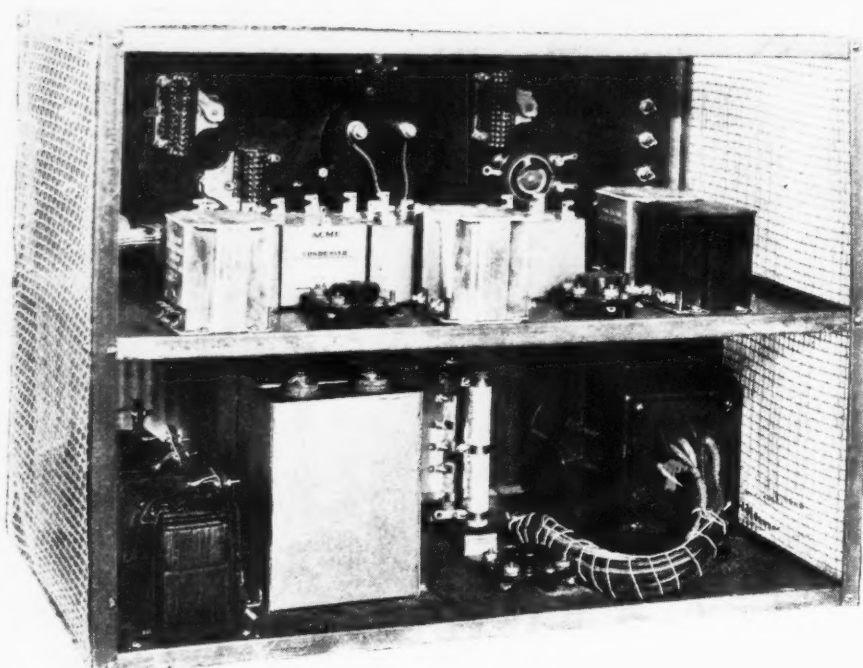
scarcely gotten under way. With production of receivers well under way, with orders from dealers mounting on the manufacturers' books, and bearing in mind that an average of six tubes is required for each new receiver, and the further fact that replacements form the basis for even more tube sales, it will probably not be difficult to see that the future opportunities of the tube-making industry may be numbered among the great.



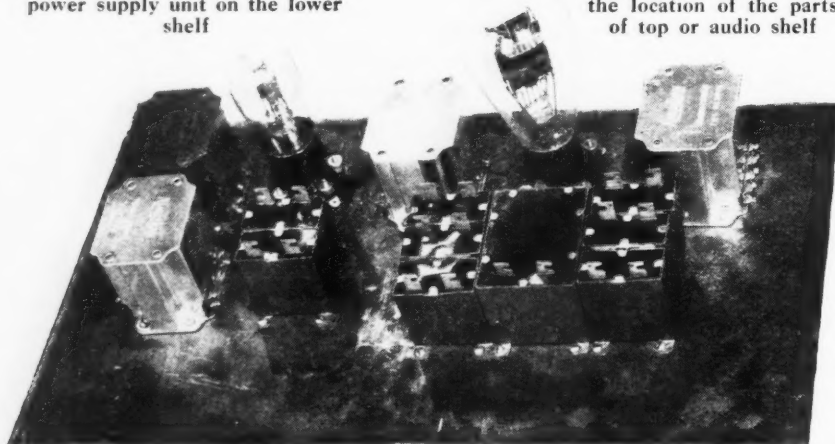
This COMPACT FLEXIBLE SPEECH AMPLIFIER

*Provides a New Source of
Income for the
Radio
Serviceman*

By S. Gordon Taylor



The audio amplifier channel is located on the upper and the power supply unit on the lower shelf



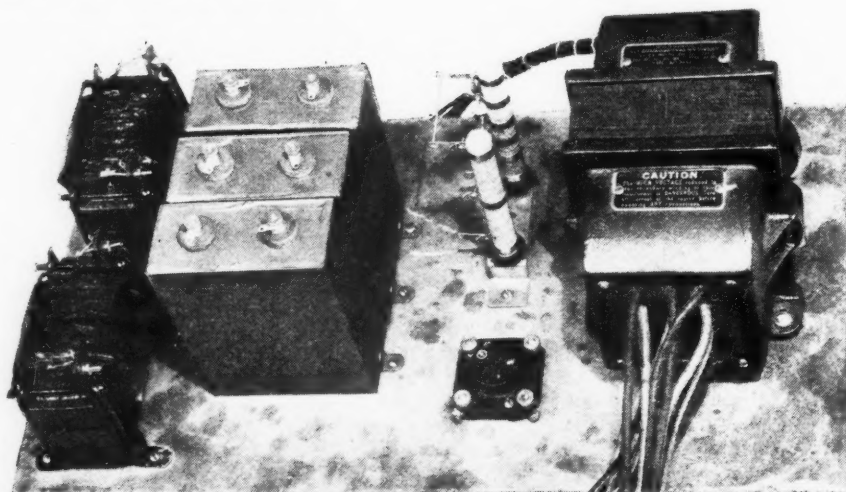
This photograph shows the location of the parts of top or audio shelf

helpful when for later jobs it is desired to select manufactured equipment. Moreover, the detailed knowledge of every function and part of the equipment makes the installation man better able to cope with any emergencies that may arise in installations employing standard manufactured equipment.

With the foregoing idea in mind, this third article of the series is to be devoted to a description of a complete power amplifier unit, especially designed to meet the requirements of commercial service. This unit is intended for installation where the volume and the coverage desired do not require such a high power output as could be supplied by a push-pull 250 job, but where more power is required than can be provided by the average radio receiver which does not employ an external power amplifier.

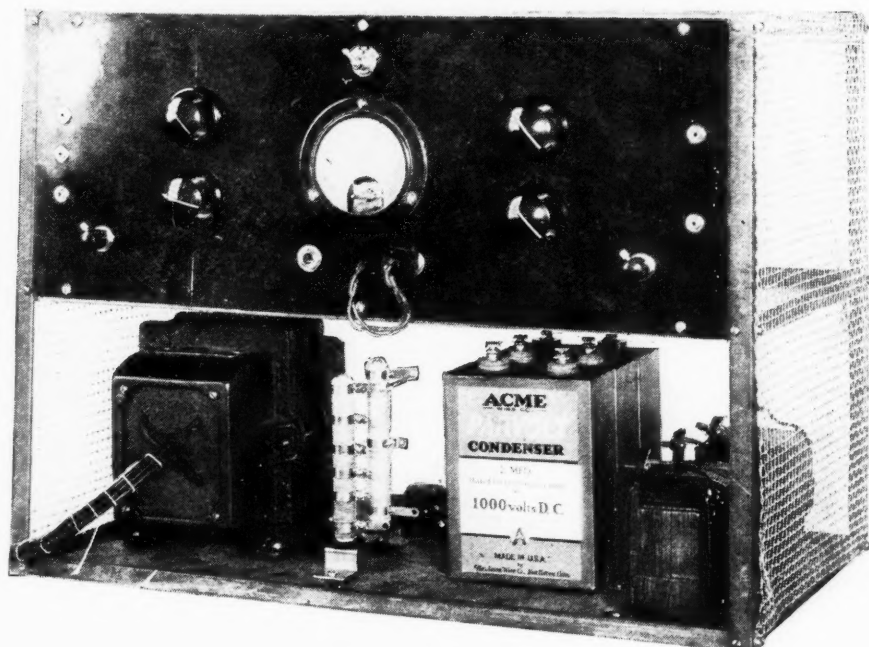
This description is not offered as a standard to be followed in exact detail for all medium sized installations. While it will probably serve to excellent advantage in the majority of such cases, it will in others require some minor changes

Here is shown the layout of the power supply parts on the metal base plate



READERS who have been following this series of articles will remember that in the first article, which appeared in the August issue, a suggestion was made that those entering the sound amplifier installation field can best start with a small job in order to become familiar with the requirements for this type of service. It was further suggested that a great deal of useful technical knowledge could be obtained by assembling the entire amplifier and power supply equipment for the first job or two. The idea behind this suggestion was that power amplifiers for use in stores, hotels, amusement places, etc., differ somewhat in detail from those ordinarily employed in the home.

The experience gained in building one of the commercial type should prove



to adapt it to the particular requirements of a given job. In any event, the description will serve to point out some of the special requirements called for by equipment which is to be used in commercial service. So far as the writer knows, some of these special features have never been included in descriptive articles published heretofore.

Commercial amplifiers, a convenient term to distinguish equipment used in schools, hotels, etc., from that ordinarily

All controls are easily accessible, being mounted on the panel. A wire screen covers the lower front

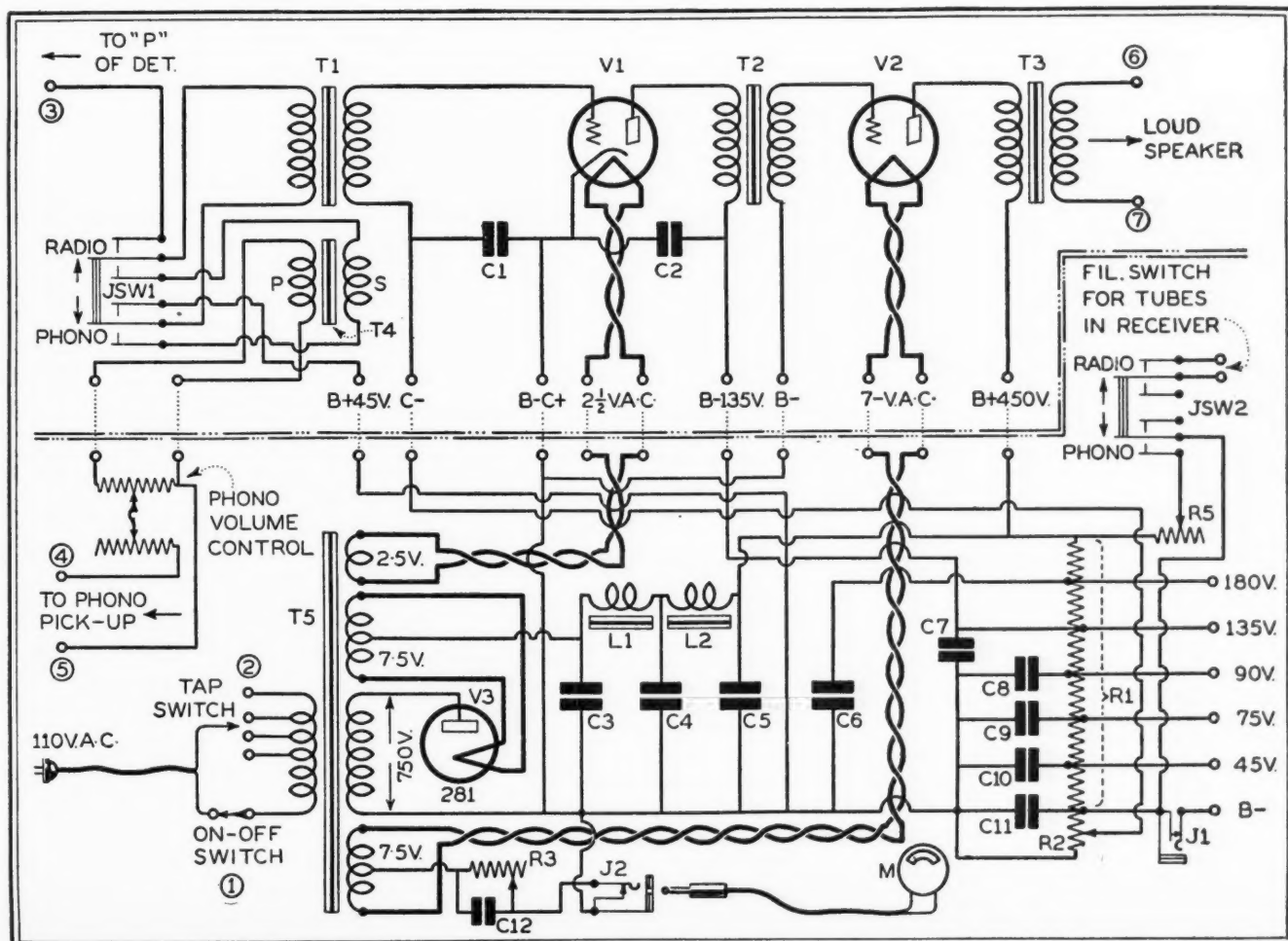
employed in the home, involves special considerations. One of the first requirements is that such equipment be made foolproof, because in almost every case it is to be operated by someone who knows nothing about its technicalities. Obviously, the owner wants to feel that he can expect continuous service with-

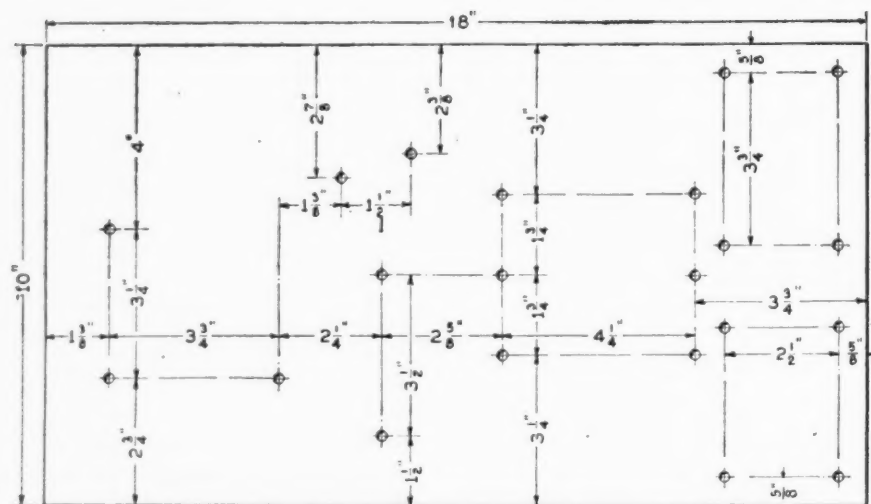
out the necessity for calling in a service man every week or so. Every trouble-free installation serves as a good advertisement for the installation man, whereas frequent breakdowns on one installation may provide unfavorable publicity which will be hard to live down.

Local and Underwriters' Regulations Should Be Observed

The second main requirement is that the equipment be so designed and constructed as to eliminate all fire and accident hazards. This is a most important consideration and one which has received too little attention heretofore in radio and amplifier installations. It is considered so important that the National Board of Fire Underwriters are now formulating definite requirement standards. Final requirements have not been released as yet, but some of the tentative rules have been published, and in designing the amplifier described below, these tentative requirements have been kept in mind. In this connection it is suggested that installation men consult local boards or building inspectors to determine any special local requirements that may exist. Some of these agencies have formulated very definite standards which must be followed.

The complete schematic circuit of the speech amplifier, power supply device. By means of the switches shown, ready changeover from radio to electric phonograph is possible





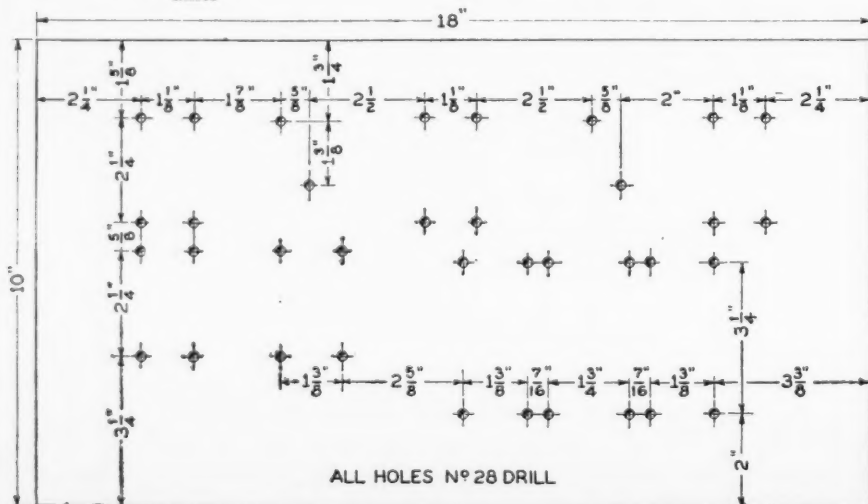
Unique Constructional Features Embodied in Design

It may be well to start the description with a brief summary of the outstanding features embodied in this amplifier. In the first place, the entire unit is enclosed, but at the same time adequate ventilation is provided to dissipate the normal operating heat. Such enclosure is one of the few definite requirements of the Board of Underwriters. It prevents the operator from coming in contact with live parts; it protects the equipment itself from injury, and eliminates the fire hazard which may sometimes result from loose connections in high potential circuits.

All controls, switches, etc., are mounted on the outside front panel. Such as are not completely insulated are at ground potential so that there is no possibility of the operator receiving a shock. This is particularly true of the metallic switch knobs and the meter jacks. The former are insulated from current carrying circuits and the latter are at ground potential.

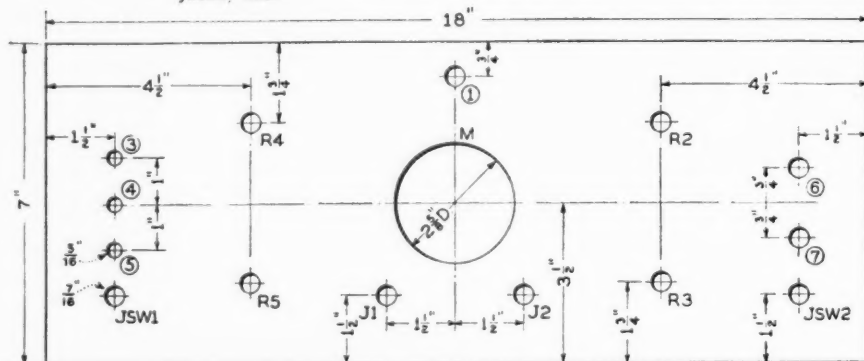
All parts employed in the entire unit are selected for their quality, and are such as to provide an ample factor of safety, thus guarding against a breakdown. The frame and the shelving are

The template for drilling the upper shelf. The steel panel, of which this shelf is made, eliminates magnetic coupling between the audio and power units



This is the lower shelf drilling template for the power and filter apparatus; all holes are drilled with a No. 28 drill

The layout of the control panel on which are placed the change-over switches, grid bias resistors, plate jacks, etc.



of metal construction, as is also the wire mesh which forms part of the housing. Grounding this metal work automatically grounds the cases of the individual instruments which are mounted thereon.

A line voltage control switch, Tap Switch No. 2, has been included to adapt the unit to the prevailing line voltage. No line voltmeter has been included in the set-up, but in localities where the line voltage fluctuates throughout the day, such a meter should be installed to permit the voltage regulator switch to be properly adjusted to meet these fluctuations.

One unusual feature of this amplifier is found in the use of a bleeder resistance, which is automatically cut into the circuit when the radio receiver is turned off. This is required in cases where the amplifier is used with a phonograph part of the time. Inasmuch as the amplifier unit supplies plate voltages for a radio-frequency tuner, the plate voltages for the amplifier tubes would be increased when the tuner is turned off because of the decreased load. If the tuner employed contains only two or three tubes with low plate current consumption, the excess current would be little cause for worry. In many cases, however, the r. f. tubes may require 8 to 20 milliamperes. With the receiver turned off, this excess current would be sufficient to overload the amplifier tubes and eventually cause breakdowns.

The amplifier, as will be seen from a study of the schematic diagram, includes two stages with a single 350 power tube in the second stage. Normally, two audio stages are used ahead of a 350 power stage, but with the growing use of power detection, this is no longer considered necessary. With suitable input

voltage from the receiver, this amplifier is capable of operating one or two dynamic speakers and up to thirty magnetic cone speakers, depending on the volume required from each speaker.

Input transformers T1 and T4, are provided for both radio and phonograph inputs respectively, with a switch JSW1 on the panel to permit instantaneous selection of either. Another switch JSW2 on the amplifier panel turns the receiver off when it is desired to use the phonograph. This latter switch also cuts in the bleeder resistance R5, referred to above.

A phonograph volume control, R4, is mounted on the amplifier panel, as is also a milliammeter with cord and plug. Two jacks are provided for plugging in the milliammeter. One of these, J2, provides a plate current reading for the 350 tube; the other gives a reading of all other plate currents combined. These two jacks, with the milliammeter, provide a definite check on the plate circuits of all tubes.

One Power Section

The power supply unit incorporated in the amplifier supplies all of the A, B & C voltages for the amplifier, and also the plate voltages for the radio receiver. It is intended that the filaments of the receiver be operated from a storage battery which is connected through the re-

(Continued on page 378)

A COMPACT RECEIVER *for* *Auto, Plane or Motorboat*

*Entire Broadcast Range Can Be Covered by This
Single-Dial Receiver Equipped With Remote Control*

FROM the photographs it will be seen that the receiver illustrated here is extremely compact. The antenna required is very short. The entire antenna length is illustrated in the

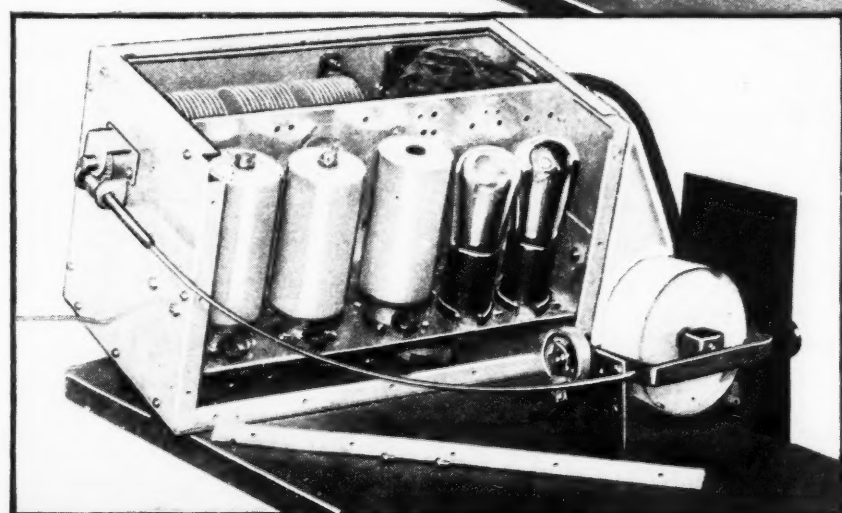
top view, and as may be observed by comparing it with the foot-rule standing beside the receiver, has a total length of approximately three feet. The entire case is made of angle aluminum and sheet aluminum, which makes the unit very rugged. The single driving shaft for the condenser assembly terminates in a gear which meshes with a worm drive attached to one end of the flexible remote control driving unit. The other end of this unit is attached to the dial by another gear arrangement. The compactness of the receiver makes it possible to install it under the dash in an automobile, in some convenient part of the fuselage in an aeroplane, or in any remote compartment in

a motorboat away from a source of interference.

The volume control and tuning control may be carried to the dash or any other convenient place. The receiver itself is made with a.c. tubes operated from a d.c. or storage battery source, in order to reduce the possible pick-up of ignition noise from the high tension spark-plug lines. Two screen-grid tubes are used in the r.f. circuit, a 112A tube is used for the detector; this feeds into a three-stage resistance-coupled audio amplifier, which provides good tone quality. The use of resistance coupling makes the entire design of light weight.

The model shown here was designed by George A. Eckweiler and A. Gillette Clark. Another receiver, of somewhat similar nature, developed by RADIO NEWS Laboratory staff will be described in complete detail in an early issue.

The compact, completely shielded, remote control, battery operated receiver for auto, plane and boat use weighs less than seven pounds, and its size may be judged from the rule standing beside it.



With two of the outside surfaces of the combination shield and container removed the position of most of the units may well be visualized. From this layout other designs will suggest themselves to the experienced radio constructor.

List of Broadcast Stations in the United States and Canada

(Alphabetically, by Call Letters)

Radio Call Letters	BROADCAST STA. Location	Wave (Meters)	Power (Watts)	Radio Call Letters	BROADCAST STA. Location	Wave (Meters)	Power (Watts)	Radio Call Letters	BROADCAST STA. Location	Wave (Meters)	Power (Watts)
KCRC	Enid, Okla.	219	100	KGIX	Las Vegas, Nevada	211	100	KWEA	Shreveport, La.	248	100
KDB	Santa Barbara, Calif.	200	100	KGJF	Little Rock, Ark.	337	250	KWJJ	Portland, Ore. (Ltd.)	283	500
KDKA	East Pittsburgh, Pa.	306	5000	KGKB	Brownwood, Texas	200	100	KWK	St. Louis, Mo.	222	1000
KDLR	Devils Lake, N. D.	248	100	KGKL	San Angelo, Texas	219	100	KWKC	Kansas City, Mo.	219	100
KDYL	Salt Lake City, Utah	232	1000	KGKO	Wichita Falls, Texas	526	250	KWKH	Kennonwood, La.	353	2000
KEJK	Los Angeles, Calif. (Ltd.)	256	500	KGKX	Sandpoint, Idaho	211	15	KWLC	Decorah, Iowa (day)	236	100
KELW	Burbank, Calif.	384	500	KGO	Oakland, Calif.	380	7500	KWSC	Pullman, Wash.	216	500
KEX	Portland, Oregon	254	5000	KGRC	San Antonio, Texas	219	100	KWTC	Santa Ana, Calif.	200	100
KFAB	Lincoln, Nebraska	389	5000	KGRS	Amarillo, Texas	213	1000	KWWG	Brownsville, Texas	238	500
KFAD	Phoenix, Arizona	484	500	KGU	Honolulu, Hawaii	484	1000	KWYO	Laramie, Wyoming	500	500
KVBB	Harve, Montana	220	500	KGW	Portland, Oregon	319	500	KXA	Seattle, Wash.	526	500
KFBK	Sacramento, Calif.	229	100	KGY	Lacey, Washington (day)	250	50	KXL	Portland, Oregon	240	500
KFBL	Everett, Washington	219	50	KHJ	Los Angeles, Calif.	333	1000	KXO	El Centro, Calif.	250	100
KFDM	Beaumont, Texas	535	500	KHO	Spokane, Wash.	508	1000	KXRO	Aberdeen, Wash.	211	75
KFDY	Brookings, S. D. (day)	545	1000	KICK	Red Oak, Iowa	211	100	KYA	San Francisco, Calif.	244	1000
KFEL	Denver, Colorado	319	250	KID	Idaho Falls, Idaho	240	1000	KYWA	See KFKX		
KFEQ	St. Joseph, Mo. (day)	535	2500	KIDO	Yakima, Washington	219	50	KZM	Oakland, Calif.	294	500
KFGQ	Boone, Iowa	229	100	KIT	San Francisco, Cal. (day)	280	100	KZM	Arlington, Va.	434	1000
KFH	Wichita, Kansas	231	500	KJBS	Seattle, Wash.	309	5000	NAA	Chicago, Ill. (day)	326	500
KFHA	Gunnison, Colorado	250	50	KJR	Blytheville, Ark. (day)	232	200	WAAT	Newark, N. J. (day)	240	2000
KFI	Los Angeles, Calif.	468	5000	KLCN	Ogden, Utah	216	1000	WAAT	Jersey City, N. J. (day)	280	300
KFIF	Portland, Oregon	211	100	KLR	Oakland, Calif. (day)	208	250	WAB	New York City	349	5000
KFIO	Spokane, Wash. (day)	244	100	KLS	Oakland, Calif.	341	500	WABI	Bangor, Me.	250	100
KFIZ	Fond du Lac, Wis.	211	100	KLX	Dupont, Colo.	535	1000	WABO	Rochester, N. Y.	208	500
KFJB	Marshalltown, Iowa	250	100	KMA	Shenandoah, Iowa (day)	322	1000	WABZ	New Orleans, La.	250	100
KFJF	Oklahoma City, Okla.	204	5000	KMBC	Independence, Mo. (day)	316	2500	WADC	Akron, Ohio	227	1000
KFJH	Astoria, Oregon	219	100					WADM	Detroit, Mich.	200	100
KFJM	Grand Forks, N. D.	219	100					WAGM	Royal Oak, Mich.	229	50
KFJR	Portland, Oregon	231	500					WAIU	Columbus, Ohio (Ltd.)	468	500
KFJY	Fort Dodge, Iowa	229	100					WAPI	Birmingham, Ala.	263	5000
KFJZ	Fort Worth, Texas	219	100					WASH	Grand Rapids, Mich.	236	250
KFKA	Greeley, Colorado (day)	341	1000					WBAK	Harrisburg, Pa. (day)	210	1000
KFKB	Millford, Kansas (day)	286	5000					WBAL	Baltimore, Md.	283	1000
KFKU	Lawrence, Kansas	246	1000					WBAP	Fort Worth, Texas (LP)	375	5000
KFKX	Chicago, Illinois	594	5000					WBAW	Nashville, Tenn.	201	5000
KFKZ	Kirksville, Missouri	250	15					WBAX	Wilkes-Barre, Pa.	248	100
KFLV	Rockford, Illinois	213	500					WBBC	Brooklyn, N. Y. City	214	500
KFLX	Galveston, Texas	219	100					WBBL	Richmond, Va.	389	100
KFMX	Northfield, Minn.	240	1000					WBMM	Chicago, Ill.	200	1000
KFNF	Shenandoah, Iowa (day)	337	1000					WBRR	Rossville, N. Y. City	231	1000
KFOR	Lincoln, Nebraska	248	100					WBBY	Charleston, S. C.	250	75
KFOX	Long Beach, Calif.	240	1000					WBBZ	Ponca City, Okla.	250	100
KFPL	Dublin, Texas	229	15					WBCN	Bay City, Mich.	213	500
KFPM	Greenville, Texas	229	15					See WENR	Quincy, Mass.	244	1000
KFPW	Siloam Springs, Ark. (day)	224	50					WBMS	Fort Lee, N. J.	207	200
KFPY	Spokane, Wash.	224	5000					WBNY	New York City	222	250
KFOA	St. Louis, Mo.	500	5000					WBOQ	See WABC		
KFOD	Anchorage, Alaska	244	100					WBOW	Terre Haute, Ind.	229	100
KFOU	Holy City, Calif.	211	100					WBRC	Birmingham, Ala. (day)	322	1000
KFOW	Seattle, Wash.	211	100					WBRE	Wilkes-Barre, Pa.	229	1000
KFOZ	Hollywood, Cal. (Ltd.)	349	250					WBRL	Tilton, N. H.	210	500
KFRK	San Francisco, Calif.	492	1000					WBSS	Wellesley Hills, Mass. (day)	384	250
KFRU	Columbia, Missouri	375	500					WBT	Charlotte, N. C.	278	5000
KFSD	San Diego, Calif. (day)	500	1000					WBZ	Springfield, Mass.	303	15000
KFSG	Los Angeles, Calif.	268	500					WBZ	Boston, Mass.	303	500
KFUL	Galveston, Texas	232	1000					WBZ	Camden, N. J.	240	1000
KFUM	Colorado Springs, Colo	236	1000					WCAC	Canton, N. Y. (day)	246	500
KFUO	Layton, Mo.	545	500					WCAC	Pittsburgh, Pa.	246	500
KFUP	Denver, Colorado	100	1000					WCAH	Columbus, Ohio	210	500
KFVD	Culver City, Calif. (Ltd.)	422	250					WCAL	Lincoln, Neb.	508	500
KFVS	Cape Girardeau, Mo.	248	100					WCAM	Northfield, Minn.	240	1000
KFWB	Hollywood, Calif.	316	1000					WCAO	Baltimore, Md.	500	250
KFWC	Ontario, Calif.	250	100					WCAP	Asbury Park, N. J.	234	500
KFWF	St. Louis, Missouri	250	100					WCAT	Rapid City, S. D.	250	100
KFWI	San Francisco, Calif.	322	500					WCBA	Philadelphia, Pa.	256	10000
KFWM	Oakland, Calif.	322	500					WCAL	Chicago, Ill. (day)	280	500
KFXD	Jerome, Idaho	211	50					WCFL	Allentown, Pa.	208	250
KFXF	Denver, Colorado	319	250					WCBD	Zion, Illinois (day)	278	5000
KFXR	Edgewater, Colo.	229	50					WCBM	Baltimore, Md.	217	100
KFXJ	Oklahoma City, Okla.	229	100					WCBS	Springfield, Ill.	248	100
KFXK	Flagstaff, Arizona	211	100					WCCO	Minneapolis, Minn.	370	15000
KFYU	Ablene, Texas	211	100					WCCO	New York City	222	250
KFYR	Bismarck, N. D.	545	500					WCFL	Chicago, Ill. (Ltd.)	309	1500
KGA	Spokane, Wash.	204	5000					WCGU	Brooklyn, N. Y. City	214	500
KGAR	Tucson, Arizona	219	100					WCKY	Villa Madonna, Ky	203	5000
KGB	San Diego, Calif.	220	250					WCLB	Long Beach, N.Y.	200	100
KGBU	Ketchikan, Alaska	333	500					WCLO	Kenosha, Wis.	250	100
KGBX	St. Joseph, Mo.	219	100					WCMA	Joliet, Ill.	229	150
KGBZ	York, Nebraska	322	500					WCMA	Culver, Ind.	214	500
KGCA	Decorah, Iowa (day)	236	50					WCOA	Pensacola, Fla.	268	500
KGCI	San Antonio, Texas	219	100					WCOC	Columbus, Miss.	341	500
KGCR	Watertown, S. D.	248	100					WCOD	Harrisburg, Pa.	250	100
KGCU	Mandan, N. D.	250	100					WCOD	Greenville, N. Y.	248	100
KGDX	Vida, Montana	211	10					WCOR	Chicago, Ill.	248	100
KGDM	Dell Rapids, S. D.	219	50					WCSP	Portland, Maine	319	500
KGDE	Fergus Falls, Minn.	250	50					WCSP	Springfield, Ohio	217	500
KGDM	Stockton, Calif. (day)	273	50					WDAA	Tampa, Fla.	484	1000
KGDR	San Antonio, Texas	250	100					WDAA	Kansas City, Mo.	492	1000
KGDY	Oldham, S. D.	250	15					WDAG	Amarillo, Texas	213	250
KGEF	Los Angeles, Calif.	231	1000					WDAG	El Paso, Texas	229	100
KGEK	Yuma, Colo.	250	50					WDAY	Fargo, N. D.	224	1000
KGER	Long Beach, Calif.	219	100					WDBJ	Roanoke, Va. (day)	322	500
KGEW	Fort Morgan, Colo	250	100					WDBO	Orlando, Fla.	484	1000
KGEZ	Kallispell, Montana	229	100					WDEL	Wilmington, Del. (day)	268	350
KGF	Alva, Oklahoma	211	50					WDGY	Minneapolis, Minn. (Ltd.)	254	1000
KGFG	Oklahoma City, Okla.	219	100					WDH	Chattanooga, Tenn.	234	500
KGFI	San Angelo, Texas	200	100					WDRS	New Haven, Conn.	225	500
KGFJ	Los Angeles, Calif.	211	100					WDSU	New Orleans, La.	236	1000
KGFK	Hallack, Minnesota	250	50					WDWF	Transton, R. I.	248	100
KGFL	Raton, New Mexico	219	50					WDZ	Cuscola, Illinois (day)	280	100
KGFV	Ravena, Nebraska	227	50					WEAF	New York City (LP)	454	50000
KGFX	Pierre, S. D. (day)	517	200					WEAL	Ithaca, N. Y. (day)	236	1000
KGGC	San Francisco, Calif.	211	50					WEAN	Providence, R. I. (day)	545	500
KGGF	Picher, Oklahoma	297	500					WEAO	Columbus, Ohio	545	750
KGGM	Albuquerque, N. M.	219	100					WEAR	Cleveland, Ohio	280	1000
KGGH	Pueblo, Colorado	227	250					WEBC	Superior, Wis.	234	1000
KGGI	McGee, Ark.	229	50					WEBC	Cambridge, Ohio	248	100
KGIL	Little Rock, Ark.	200	100					WEBO	Harrisburg, Ill.	248	100
KGHL	Billings, Montana	316	500					WEBO	Buffalo, N. Y., (day)	229	200
KGHX	Richmond, Texas	200	50								
KGIH	Twin Falls, Idaho	227	250								
KGIJ	Butte, Montana	220	250								
KGIW	Trinidad, Colo.	211	100								

THIS list of stations in the United States operating under licenses issued by the Federal Radio Commission is corrected to April 30, 1929. Powers shown are the night strength, or minimum.

Radio Call Letters	BROADCAST STA. Location	Wave (Meters)	Power (Watts)	Radio Call Letters	BROADCAST STA. Location	Wave (Meters)	Power (Watts)	Radio Call Letters	BROADCAST STA. Location	Wave (Meters)	Power (Watts)
WEBW	Beloit, Wis. (day)	500	350	WJBK	Ypsilanti, Mich.	219	50	WNRC	Greensboro, N. C.	208	250
WEDC	Chicago, Ill.	248	100	WJBN	Decatur, Ill.	250	100	WNYC	New York City	526	500
WEDH	Erie, Pa.	211	30	WJBO	New Orleans, La.	219	100	WOAI	San Antonio, Texas	252	500
WEEL	Boston, Mass.	508	500	WJBT	See WBBM			WOAN	Lawrenceburg, Tenn.	800	500
WEHS	Evanston, Ill.	229	100	WJBU	Lewisburg, Pa.	248	100	WOAX	Trenton, N. J.	234	500
WELK	Philadelphia, Pa.	219	100	WJBW	New Orleans, La.	250	30	WOBT	Union City, Tenn.	229	15
WEMC	Berrien Springs, Mich. (day)	508	1000	WJBY	Gadsden, Ala.	248	50	WOBU	Charleston, W. Va.	517	250
WENR	Chicago, Ill. (I.P.)	345	5000	WJJD	Moosheart, Ill. (Ltd.)	265	2000	WOC	Davenport, Iowa	300	5000
WEPB	Gloucester, Mass.	250	100	WJJS	Gary, Ind.	220	500	WOCL	Paterson, N. J.	248	25
WEVD	New York City	231	500	WJRW	Pontiac, Mich.	400	5000	WODA	Ames, Iowa (day)	240	1000
WEW	St. Louis, Mo. (day)	395	1000	WJSV	Mt. Vernon Hills, Va.	205	10000	WOI	Mt. Beacon, N.Y.	208	500
WFAD	Dallas, Texas (C.P.)	375	500 50kw	WJW	Mansfield, Ohio	248	100	WOL	Washington, D.C.	229	100
WFAN	Philadelphia, Pa.	492	500	WJZ	New York City (L. P.)	395	3000	WOMT	Manitowoc, Wis.	248	100
WFBC	Knoxville, Tenn.	250	50	WKAA	San Juan, Porto Rico	337	500	WOOD	Grand Rapids, Mich.	236	500
WFBG	Altoona, Pa.	229	100	WKAR	East Lansing, Mich. (day)	288	1000	WOPI	Bristol, Tenn.	200	100
WFBJ	Collegeville, Minn.	219	100	WKAV	Laconia, N. H.	229	100	WOQ	Kansas City, Mo.	492	1000
WFBM	Syracuse, N. Y.	333	750	WKBB	Joliet, Ill.	229	100	WOR	Newark, N. J.	422	5000
WFBP	Indianapolis, Ind. (Ltd.)	244	1000	WKBC	Birmingham, Ala.	229	100	WORD	Chicago, Ill.	203	5000
WFBT	Baltimore, Md. (temp.)	236	250	WKBE	Wester, Mass.	250	100	WOW	Jefferson City, Mo.	476	500
WFD	Flint, Michigan	229	100	WKBF	Indianapolis, Ind.	214	500	WOW	New York City (day)	265	1000
WFI	Philadelphia, Pa.	535	500	WKBH	La Crosse, Wis.	217	1000	WOW	Omaha, Neb.	508	1000
WFIW	Hopkinsville, Ky.	319	1000	WKBI	Chicago, Ill.	229	50	WOWO	Fort Wayne, Ind.	258	1000
WFJC	Akron, Ohio	207	500	WKBN	Youngstown, Ohio	526	500	WPAP	New York City	297	250
WFKD	Philadelphia, Pa.	229	50	WKBO	Jersey City, N. J.	207	250	WPAP	Pawtucket, R. I.	248	100
WFLA	See WSLA			WKBP	Belle Creek, Mich.	211	100	WPC	Chicago, Ill.	526	500
WGAL	Lancaster, Pa.	229	15	WKBU	Lancaster, Pa.	222	100	WPC	New York City (day)	273	5000
WGBB	Freeport, N. Y.	248	100	WKBS	Galesburg, Ill.	229	100	WPG	Atlantic City, N. J.	211	30
WGBC	Memphis, Tenn.	210	500	WKBV	Brookville, Ind.	200	100	WPOE	Patchogue, N. Y.	211	30
WGBF	Evansville, Ind.	476	500	WKBW	Buffalo, N. Y.	204	5000	WPS	See WTAR		
WGBI	Scranton, Pa.	250	250	WKBY	Ludington, Mich.	200	50	WPS	State College, Pa. (day)	244	500
WGBS	New York City (Limited)	250	1000	WKBY	Buffalo, N. Y. (Ltd.)	250	1000	WPS	Philadelphia, Pa.	200	50
WGCM	Gulport, Miss.	248	100	WKBY	Lancaster, Pa.	222	100	WPTF	Raleigh, N. C.	441	1000
WGCP	Newark, N. J.	240	250	WKRC	Cincinnati, Ohio	545	500	WQAM	Miami, Fla.	242	1000
WGES	Chicago, Ill.	220	500	WKY	Oklahoma City, Okla.	333	1000	WQAO	See WPAP		
WGH	Newport News, Va.	229	100	WLAC	Nashville, Tenn.	201	5000	WQB	Utica, Miss.	220	300
WGHP	Fraser, Mich.	282	750	WLAP	Louisville, Ky.	250	30	WQBZ	Weirton, W. Va.	211	60
WGL	Fort Wayne, Ind.	219	100	WLBP	Minneapolis, Minn.	240	500	WRAF	LaPorte, Ind.	250	100
WGMS	See WLB			WLB	Muncie, Ind.	229	100	WRAW	Reading, Pa.	229	100
WGN	Chicago, Ill.	416	25000	WLB	Kansas City, Mo.	211	100	WRAX	Philadelphia, Pa. (day)	246	250
WGR	Buffalo, N. Y.	545	1000	WLBG	Ettrick, Va.	250	100	WRBC	Valparaiso, Ind. (day)	242	500
WGST	Atlanta, Ga. (day)	337	250	WLB	Stevens Point, Wis. (day)	333	2000	WRBI	Tifton, Ga.	229	20
WGY	Schenectady, N. Y.	380	5000	WLBW	Oil City, Pa.	238	500	WRBJ	Hattiesburg, Miss.	200	10
WHA	Madison, Wis. (day)	319	750	WLBW	Long Island City, N. Y.	200	100	WRBL	Columbus, Ga.	250	50
WHAD	Milwaukee, Wis.	268	250	WLBZ	Bangor, Maine	484	250	WRBQ	Greenville, Miss.	248	100
WHAM	Rochester, N. Y.	261	5000	WLCI	Ithaca, N. Y.	248	50	WRBT	Wilmington, N. C.	219	100
WHAP	New York City	231	1000	WLEX	Medford, Mass.	220	500	WRBU	Gastonia, N. C.	248	100
WHAS	Louisville, Ky.	366	5000	WLEY	Lexington, Mass.	211	100	WRC	Washington, D. C.	316	500
WHAZ	Troy, N. Y.	231	500	WLIE	See WGN			WREC	Memphis, Tenn.	500	500
WHBC	Canton, Ohio	250	10	WLOE	Philadelphia, Pa.	535	500	WREN	Lawrence, Kansas	246	1000
WHBD	Bellefontaine, Ohio	219	100	WLS	Chicago, Ill.	345	5000	WRHM	Minneapolis, Minn.	240	1000
WHBF	Rock Island, Ill.	248	100	WLSI	See WDW			WRJN	Racine, Wis.	219	100
WHBL	Sheboygan, Wis.	213	500	WLTH	Brooklyn, N. Y.	214	500	WRK	Hamilton, Ohio	229	100
WHBP	Johnstown, Pa.	229	100	WLW	Cincinnati, Ohio (L.P.)	428	5000	WRNY	New York City	297	250
WHBO	Memphis, Tenn.	219	100	WLW	New York City	273	250	WRB	Dallas, Texas	234	500
WHBU	Anderson, Ind.	248	100	WMA	Cazenovia, N. Y.	526	500	WRUF	Gainesville, Fla.	517	500
WHBY	West De Pere, Wis. (L. T.)	250	100	WMAF	So. Dartmouth, Mass.	220	500	WRVA	Richmond, Va.	270	1000
WHDF	Calumet, Mich.	219	100	WMAK	Buffalo, N. Y.	333	750	WSAI	Cincinnati, Ohio (Ltd.)	226	500
WHDH	Gloucester, Mass. (day)	361	1000	WMAL	Washington, D. C.	476	250	WSAJ	Grove City, Pa.	229	100
WHD	Minneapolis, Minn. (L. T.)	254	1500	WMAN	Columbus, Ohio	248	50	WSAN	Allentown, Pa.	208	250
WHD	Tupper Lake, N. Y. (day)	211	10	WMAN	Chicago, Ill.	447	5000	WSAP	Portsmouth, R. I.	207	250
WHFC	Cicero, Ill.	229	100	WMAZ	Macon, Ga.	337	250	WSB	Atlanta, Ga.	405	1000
WHIS	Bluefield, W. Va.	211	100	WMBA	Newport, R. I.	200	100	WSBT	South Bend, Ind.	244	500
WHK	Cleveland, Ohio	216	1000	WMBC	Detroit, Mich.	211	100	WSDA	Brooklyn, N. Y.	214	500
WHN	New York City	297	250	WMBD	Peoria, Ill.	208	500	WSGH	See WSDA		
WHO	Des Moines, Iowa	300	500	WMBG	Richmond, Va.	248	100	WSIX	Springfield, Tenn.	248	100
WHOP	Harrisburg, Pa.	210	500	WMBH	Joplin, Mo.	211	100	WSM	Nashville, Tenn.	461	5000
WHAS	Ottumwa, Iowa	211	100	WMBI	Chicago, Ill. (Ltd.)	278	5000	WSMB	New Orleans, La.	227	500
WIBA	Madison, Wis.	248	100	WMBJ	Wilkinsburg, Pa.	200	100	WSMK	Dayton, Ohio	526	200
WIBG	Elkins Park, Pa. (day)	322	50	WMBL	Lakeland, Fla.	229	100	WSOA	Deerfield, Ill.	203	5000
WIBM	Jackson, Mich.	219	100	WMBQ	Auburn, N. Y.	219	100	WSPD	Toledo, Ohio	224	500
WIBO	Chicago, Ill.	526	1000	WMBQ	Brooklyn, N. Y.	200	100	WSSH	Bozeman, Miss.	211	100
WIBR	Steubenville, Ohio	211	250	WMBT	Tampa, Fla.	248	100	WSUI	Iowa City, Iowa	517	500
WIBS	Elizabeth, N. J.	207	500	WMC	Memphis, Tenn.	526	500	WSUN	St. Petersburg, Fla.	333	1000
WIBU	Poynette, Wis.	229	100	WMCA	New York City	526	500	WSVS	Buffalo, N. Y.	219	50
WIBW	Topeka, Kans.	231	1000	WMES	Boston, Mass.	200	50	WSYR	Syracuse, N. Y.	526	250
WIBX	Utica, N. Y.	250	100	WMFM	Fairmont, W. Va.	337	250	WTAD	Quincy, Ill.	208	500
WICC	Bridgeport, Conn. (day)	252	500	WMPC	Lapeer, Mich.	200	100	WTAC	Worcester, Mass.	517	250
WIL	St. Louis, Mo.	250	100	WMRJ	Jamaica, N. Y. City	211	10	WTAM	Cleveland, Ohio	280	3500
WILL	Urbana, Ill.	337	250	WMSG	New York City	222	250	WTAQ	Washington, Wis.	225	1000
WILM	Wilmington, Del.	211	100	WMT	Waterloo, Iowa	250	100	WTAR	Norfolk, Va.	384	500
WINR	Bay Shore, N. Y.	248	100	WMAC	See WBIS			WTAW	College Station, Texas	268	500
WIOD	Miami Beach, Fla.	535	1000	WMAD	Norman, Okla.	297	500	WTAX	Stratford, Ill.	248	50
WIP	Philadelphia, Pa.	492	500	WMAT	Philadelphia, Pa.	229	100	WTBO	Cumberland, Md.	217	50
WISN	Milwaukee, Wis.	268	250	WMAX	Yankton, S. D.	526	1000	WTFI	Toccoa Falls, Ga.	207	250
WJAD	Waco, Texas	242	1000	WMNB	Philadelphia, N. Y.	200	50	WTIC	Hartford, Conn.	500	250
WJAG	Norfolk, Neb. (day)	283	1000	WMNB	New Bedford, Mass.	229	100	WTMJ	Milwaukee, Wis.	484	1000
WJAK	Marion, Ind.	229	50	WMNJ	Knoxville, Tenn.	229	50	WVAE	Hammond, Ind.	250	100
WJAR	Providence, R. I.	337	250	WMNO	Washington, Pa.	250	100	WVNC	Detroit, Mich.	326	1000
WJAS	Pittsburgh, Pa.	232	1000	WMNB	Memphis, Tenn.	210	500	WWL	New Orleans, La.	526	1000
WJAX	Jacksonville, Fla.	238	500	WMNB	Carbondale, Pa.	250	10	WWRL	Asheville, N. C.	200	100
WJAY	Cleveland, Ohio (day)	484	500	WMNB	Springfield, Va.	250	50	WWRL	Woodsdale, N. Y.	200	100
WJAZ	Chicago, Ill.	203	5000	WMNB	Saranac Lake, N. Y. (day)	232	50	WWVA	Wheeling, W. Va.	258	250
WJBC	LaSalle, Ill.	250	100	WNJ	Newark, N. J.	207	250				
WJB	Red Bank, N. J.	248	100	WNOX	Knoxville, Tenn.	535	1000				

LIST OF CANADIAN BROADCAST CALLS

CFAC	Calgary, Alta.	434	500	CHWC	Regina, Sask.	312	500	CKGW	Bowmanville, Ont.	312	5000
CFBO	St. Johns, N. B.	337	50	CHWK	Chilliwack, B. C.	248	5	CKLC	Red Deer, Alberta	357	1000
CFCA	Toronto, Ont.	357	500	CHYC	Montreal, Que.	411	750	CKMC	Cobalt, Ont.	248	15
CFCE	Montreal, Que.	291	1650	CJBC	(See several Toronto stations)	517, 357 or 312		CKMO	Vancouver, B. C.	411	50
CFCH	Iroquois Falls, Ont.	500	250	CJBR	See CKCK			CKOC	Hamilton, Ont.	341	100
CFCL	See CKLC			CJCA	Edmonton, Alta.	517	500	CKOW	See CFCA		
CFCN	Calgary, Alta.	434	1800	CJCB	Sydney, Nova Scotia	384	50	CKPC	Preston, Ont.	248	25
CFCO	Chatham, Ont.	248	25	CJCJ	Calgary, Alta.	434	250	CKPR	Midland, Ont.	268	50
CFCT	Victoria, B. C.	476	500	CJCK	London, Ont.	329	500	CKSH	St. Hyacinthe, Que.	297	50
CFCE	Charlottetown, P. E. I.	476	100	CJGX	Yorkton, Sask.	476	500	CKW	Vancouver, B. C.	411	100
CFJC	Kamloops, B. C.	268	15	CJHS	Saskatoon, Sask.	329	250	CKX	Brandon, Man.	556	500
CFLC	Prescott, Ontario	297	50	CJOC	Lethbridge, Alta.	268	50	CKY	Winnipeg, Man.	384	5000
CFNB	Fredericton, N. B.	248	50	CJOR	Sea Island, B. C.	291	50	CNRA	Moncton, N. B.	476	500
CFQC	Saskatoon, Sask.	329	500	CJRM	Moose Jaw, Sask.	500	500	CNE	See CFAC		
CFRB	Toronto, Ont.	312	1000	CJRW	Fleming, Sask.	500	500	CNRM	See CHYC, CKAC, or CFCE		
CFRC	Kingston, Ont.	268	500	CJSC	See CKCL			CNRO	Ottawa, Ont.	434	500
CHCA	See CJCJ			CKAC	Montreal, Que.	411	1200	CNRR	See CKCV		
CHCK	Charlottetown, P. E. I.	312	30	CKCD	Vancouver, B. C.	411	50	CNRS	See CKCK		
CHCS	Hamilton, Ont.	341	10	CKCI	Quebec, Que.	500	23	CNRT	See CFCA		
CHCT	See CKCL			CKCK	Regina, Sask.	312	500	CNRV	Vancouver, B. C.	291	500
CHGS	Summerside, P. E. I.	268	25	CKCC	Toronto, Ont.	517	100	CNRW	See CKY		
CHLS	See CKCD			CKCO	Ottawa, Ont.	434	100	VAS	Louisburg, Nova Scotia	434	
CHMA	Edmonton, Alta.	517	250	CKCR	Brantford, Ont.	297	50				
CHML	Mount Hamilton, Ont.	341	50	CKCV	Quebec, Que.	500	50				
CHNC	See CKNC			CKFC	Vancouver, B. C.	411	50				

Wave (Meters)	Radio Call Letters	BROADCAST STA. Location	Power (Watts)	Wave (Meters)	Radio Call Letters	BROADCAST STA. Location	Power (Watts)	Wave (Meters)	Radio Call Letters	BROADCAST STA. Location	Power (Watts)
543.1	KFDV	Brookings, S. D.	500	322.4	KFWI	San Francisco, Calif.	500		WLBG	Euclid, Va.	100
	KFDV	Clayton, Mo.	500		KFWM	Oakland, Calif.	500		WMAY	St. Louis, La.	100
	KFYR	Bismarck, N. D.	500		KMA	Shenandoah, Iowa	500		WMT	Cedar Rapids, Iowa	100
	KSD	St. Louis, Mo.	500		WBRC	Birmingham, Ala.	500		WNBO	Washington, Pa.	100
	KTAB	Oakland, Calif.	500		WDBJ	Roanoke, Va.	250		WNBW	Carbondale, Pa.	5
	WEAN	Providence, R. I.	250		WIBG	Elkins Park, Pa. (Sunday)	50		WNBX	Springfield, Vt.	100
	WEAO	Columbus, Ohio	750	319.	KFEL	Denver, Colo.	250		WCOB	Harrisburg, Pa.	100
	WGR	Buffalo, N. Y.	1000		KFXF	Denver, Colo.	250		WOBJ	Clarksburg, W. Va.	65
	WKRC	Cincinnati, Ohio	500		KOIN	Portland, Oregon	1000		WRAF	Laporte, Ind.	100
535.4	KFDM	Beaumont, Texas	500		WCHS	Portland, Maine	500		WRBI	Columbus, Ga.	50
	KFEQ	St. Joseph, Mo. (day)	2500		WFIW	Hopkinsville, Ky.	1000		WRJN	Racine, Wis.	100
	KLZ	DuPont, Colo.	1000		WHA	Madison, Wis.	750	247.8	WWAE	Hammond, Ind.	100
	KOAC	Corvallis, Oregon	1000	315.6	KFWB	Hollywood, Calif.	1000		KDLR	Devils Lake, N. D.	100
	WFI	Philadelphia, Pa.	500		KGHI	Billings, Mont.	500		KFOR	Lincoln, Neb.	100
	WLTD	Mtiana, Fla.	1000		KMBC	Independence, Mo.	1000		KFVS	Cape Girardeau, Mo.	100
	WLIT	Philadelphia, Pa.	500		KPSN	Pasadena, Calif.	1000		KGCR	Brookings, S. D.	100
	WNOX	Knoxville, Tenn.	1000		WRC	Washington, D. C.	500		KPCB	Seattle, Wash.	100
	WOI	Ames, Iowa (day)	3500	309.1	KJRK	Seattle, Wash.	5000		KPCB	Seattle, Wash.	100
526.	KWCTO	Wichita Falls, Texas	500		KGJFL	Chicago, Ill.	1500		KWEA	Siueport, Va.	100
	KMTR	Hollywood, Calif.	500	305.9	KDKA	Pittsburgh, Pa.	50000		WBAX	Wilkes-Barre, Pa.	100
	KUOM	Missoula, Montana	500	302.8	WBZ	Springfield, Mass.	15000		WCSB	Springfield, Ill.	100
	KXA	Seattle, Wash.	500		WBZA	Boston, Mass.	500		WCOH	Greenville, N. Y.	100
	WIBO	Chicago, Ill.	1000	299.8	KPLA	Los Angeles, Calif.	1000		WCRW	Chicago, Ill.	100
	WBKN	Youngstown, Ohio	500		WHO	Des Moines, Iowa	5000		WDMF	Cranston, R. I.	100
	WMAC	Cazenovia, N. Y.	250		WIOC	Davenport, Iowa	5000		WDBF	Cambridge, Ohio	100
	WMC	Memphis, Tenn.	500	296.9	KGGF	Picher, Okla.	500		WEBQ	Harrisburg, Ill.	100
	WMCA	New York, N. Y.	500		KOW	San Jose, Calif.	500		WEDC	Chicago, Ill.	100
	WNAX	Yankton, S. D.	1000		WHN	New York, N. Y.	500		WGBM	Freeport, N. Y.	100
	WNVC	New York, N. Y.	500		WNAI	Norman, Okla.	250		WGCM	Gulfport, Miss.	100
	WPCO	Chicago, Ill.	500		WPAP	Palisade, N. J.	250		WHBF	Rock Island, Ill.	100
	WSPK	Dayton, Ohio	2000		WQMO	Buffalo, N. Y.	250		WIDU	Anderson, Ind.	100
	WSVR	Syracuse, N. Y.	250		WRNY	New York, N. Y.	250		WIBA	Madison, Wis.	100
	WWNC	Asheville, N. C.	1000						WINR	Bay Shore, N. Y.	100
516.9	KGFN	Pierre, S. D. (day)	200						WJBI	Red Bank, N. J.	100
	KSAC	Manhattan, Kansas	500						WJBU	Lewisburg, Pa.	100
	WOBU	Charleston, W. Va.	250						WJBY	Gadsden, Ala.	100
	WSAZ	Huntington, W. Va.	250						WJW	Mansfield, Ohio	100
	WSUI	Iowa City, Iowa	500						WLCT	Ithaca, N. Y.	50
	WTAG	Worcester, Mass.	250						WLST	Cranston, R. I.	100
508.2	KHO	Spokane, Wash.	1000						WMAN	Columbus, Ohio	50
	WCJ	Lincoln, Neb.	500						WMBG	Richmond, Va.	100
	WEHI	Boston, Mass.	500						WMBR	Tampa, Fla.	100
	WEMC	Berrien Springs, Mich.	1000						WOC	Tamworth, N. Y.	25
	WOW	Omaha, Neb.	1000						WOMT	Manitowoc, Wis.	100
499.7	KFSD	San Diego, Calif.	500						WPAW	Pawtucket, R. I.	100
	KWYO	Laramie, Wyo.	500	293.9	KFKX	Chicago, Ill.	5000		WRBO	Greenville, Miss.	100
	WCAC	Storrs, Conn.	250		KVW	Chicago, Ill.	5000		WRBO	Gastonia, N. C.	100
	WCAC	Baltimore, Md.	250		KVWA	Chicago, Ill.	500		WSBT	Springfield, Tenn.	100
	WEBW	Beloit, Wis.	350		WRAX	Philadelphia, Pa. (day)	10000	245.8	WTAZ	Richmond, Va.	150
	WOAN	Lawrenceburg, Tenn.	500	288.3	KTHS	Hot Springs Nat'l Park, Ark.	1000		KFKU	Lawrence, Kansas	1000
	WREC	Memphis, Tenn.	500		WKAR	East Lansing, Mich. (day)	500		WCAE	Pittsburgh, Pa.	500
491.5	KFRK	San Francisco, Calif.	1000		WFAA	Dallas, Texas	500		WCAD	Canton, N. Y. (day)	500
	WDAF	Kansas City, Mo.	1000		WKEN	Buffalo, N. Y.	1000	243.8	WREN	Lawrence, Kansas	1000
	WFAA	Philadelphia, Pa.	500	285.5	KNN	Los Angeles, Calif.	500		KFO	Spokane, Wash. (day)	100
	WIP	Philadelphia, Pa.	500	282.8	KWJL	Portland, Oregon	500		KYA	San Francisco, Calif.	1000
	WQQ	Kansas City, Mo.	1000		WBAL	Baltimore, Md.	10000		WBIS	Quincy, Mass.	500
483.6	KFAD	Phoenix, Ariz.	500		WJAG	Norfolk, Neb. (day)	500		WFBM	Indianapolis, Ind.	1000
	KGW	Portland, Oregon	1000		WTIC	Hartford, Conn.	50000		WNAI	Boston, Mass.	500
	WDNE	Tampa, Fla.	1000	280.2	WAAT	Jersey City, N. J. (day)	300		WPCO	State College, Pa. (day)	500
	WDRO	Orlando, Fla.	1000		WCAZ	Carthage, Ill. (day)	500	241.8	WSBT	South Bend, Ind.	500
	WLBZ	Bangor, Me.	250		WDZ	Fusca, Ill.	100		KTAT	Fort Worth, Texas	1000
	WTMJ	Milwaukee, Wis.	1000		WEAR	Cleveland, Ohio	1000		WGHP	Fraser, Mich.	750
475.9	KFRU	Columbia, Mo.	500		WTAM	Cleveland, Ohio	3500		WJAD	Waco, Texas	1000
	WGBF	Evansville, Ind.	500	277.6	WBDT	Charlotte, N. C.	5000		WQAM	Miami, Fla.	750
	WMAL	Washington, D. C.	250		WCBT	Zion, Ill. (day)	5000	239.9	WRBC	Valparaiso, Ind. (day)	500
	WOS	Jefferson City, Mo.	5000		WMBI	Addison, Ill. (day)	5000		KEJL	Los Angeles, Calif.	500
468.5	KFI	Los Angeles, Calif.	5000	275.1	KFOA	St. Louis, Mo.	5000		WFAX	Norfolk, Minn.	1000
	WAUI	Columbus, Ohio	500		KMOX	St. Louis, Mo.	5000		KFOX	Long Beach, Calif.	1000
461.3	WSM	Nashville, Tenn.	5000	272.6	KGBS	San Francisco, Calif. (day)	100		KIDO	Boise, Idaho	1000
454.3	WAAX	Omaha, Neb.	500		WLWL	New York City, N. Y.	5000		KXL	Portland, Oregon	500
	WEAF	Chicago, Ill.	50000		WPG	Atlantic City, N. J.	5000		WAAM	Newark, N. J.	500
447.5	WPAQ	San Francisco, Calif.	5000	270.1	KSDO	Sioux Falls, S. D. (day)	2000		WGCN	Norfolk, Minn.	1000
440.9	KFO	Raleigh, N. C.	1000		WRVA	Richmond, Va.	10000		WGCP	Newark, N. J.	250
434.5	NAA	Arlington, Va.	1000	267.7	KFSG	Los Angeles, Calif.	500		WGMS	St. Paul-Minn.	1000
	KFVD	Venice, Calif.	250		KMIC	Inglewood, Calif.	500		WLB	Minneapolis, Minn.	500
	WLW	Cincinnati, Ohio	50000		KRSC	Seattle, Wash. (day)	50		WODA	Paterson, N. J.	1000
422.3	KTM	Santa Monica, Cal.	5000		KUT	Austin, Texas	500	238	WRHM	Minneapolis, Minn.	1000
	WOK	Newark, N. J.	500		KWA	Pensacola, Fla.	500		KOIL	Council Bluffs, Iowa	500
	KFVD	Culver City, Cal.	250		WDEL	Wilmington, Del.	250		RGV	Harlingen, Texas	500
416.4	WGN	Chicago, Ill.	25000		WHAD	Milwaukee, Wis. (day)	250		KWWG	Brownsville, Texas	500
	WLBI	Chicago, Ill.	25000		WISN	Milwaukee, Wis.	250		WJAX	Jacksonville, Fla.	1000
405.2	KMMJ	Clay Center, Neb. (day)	1000		WTAW	College Station, Texas	500	236.1	WLBW	Oil City, Pa.	500
	WGB	Atlanta, Ga.	1000	265.3	KFKB	Milford, Kansas (day)	5000		KFUL	Colorado Springs, Colo.	1000
	WJR	Pontiac, Mich.	5000		KSI	Salt Lake City, Utah	5000		EGCA	Decorah, Iowa (day)	500
394.5	KVI	Des Moines, Wash.	1000		WVOV	New York, N. Y. (day)	1000		KTL	Seattle, Wash.	1000
	WEW	St. Louis, Mo. (day)	1000	263	KVOO	Tulsa, Okla.	5000		KTW	Seattle, Wash.	1000
	WJZ	New York, N. Y.	30000		WAPI	Auburn, Ala.	5000		KWLC	Decorah, Iowa (day)	100
389.4	KFAB	Lincoln, Neb.	5000	260.7	KGDM	Stockton, Calif. (day)	50		WASH	Grand Rapids, Mich.	250
	WBBI	Chicago, Ill.	10000		WHAM	Rochester, N. Y.	5000		WDSU	New Orleans, La.	1000
	WJBT	Chicago, Ill.	25000	258.5	WORO	Fort Wayne, Ind.	1000		WEAL	Washington, D. C. (day)	500
384.4	KELW	Burbank, Calif.	500		WVVA	Winchell, W. Va.	250		WFB	Baltimore, Md.	250
	WBOS	Wellesley Hills, Mass.	250	256.3	KTNT	Muscatine, Iowa (day)	5000		WOL	Washington, D. C. (day)	150
	WBOR	Norfolk, Va.	500		WCAU	Philadelphia, Pa.	10000	234.2	WOOD	Grand Rapids, Mich.	500
	WTAR	Norfolk, Va.	500	254.1	KEX	Portland, Oregon	5000		WCAM	Camden, N. J.	500
379.5	KGLA	Oakland, Calif.	7500		KOB	State College, N. Mex.	10000		WCAP	Asbury Park, N. J.	1000
	WGV	Schenectady, N. Y.	50000		KGBS	New York, N. Y.	10000		WDAY	Chattanooga, Tenn.	500
374.8	WBAP	Fort Worth, Texas	50000		WHDI	Minneapolis, Minn.	1500		WDOB	Superior, Wis.	1000
	WFAA	Dallas, Texas	500		WHJD	Mooselheart, Minn.	20000		WOAX	Trenton, N. J.	500
370.2	WCCO	Minn., St. Paul, Minn.	15000	252	WICC	Bridgeport, Conn. (day)	500		WRR	Dallas, Texas	500
	WPCB	New York, N. Y.	500		WQAI	San Antonio, Texas	5000	232.4	KDVL	Salt Lake City, Utah	1000
365.6	WIAH	Louisville, Ky.	5000		WRR	Dallas, Texas	5000		KFUL	Galveston, Texas	1000
361.2	KOA	Denver, Colo.	13500	249.9	KFJB	Marshalltown, Iowa	100		KLCN	Blytheville, Ark. (day)	50
	WHOI	Gloucester, Mass.	500		KFKZ	Kirkville, Mo.	15		KTS	San Antonio, Texas	1000
352.7	KWKH	Kennonwood, La.	20000		KFKC	Kirkville, Mo.	15		WJAS	Pittsburgh, Pa.	1000
	WWL	Gloucester, Mass.	5000		KFWC	Ontario, Calif.	100	230.6	WNBZ	Saranac Lake, N. Y. (day)	50
348.6	KFOZ	Hollywood, Calif.	250		KFCU	St. Louis, Mo.	100		KFR	Wichita, Kansas	500
	WABC	New York City, N. Y.	5000		KGEU	Mandan, N. D.	100		KFR	Portland, Oregon	500
	WBQ	New York City, N. Y.	5000		KGEU	Fergus Falls, Minn.	100		KGEF	Los Angeles, Calif.	1000
344.6	WBCN	Chicago, Ill.	25000		KGDU	Oldham, S. D.	15		KTBI	Los Angeles, Calif.	750
	WENR	Chicago, Ill.	25000		KGDK	Yuma, Colo.	50		KTBR	Portland, Oregon	500
	WLS	Chicago, Ill.	5000		KGEW	Fort Morgan, Colo.	100		WBRR	Rossville, N. Y.	1000
340.7	KFKA	Greeley, Colo.	5000		KGFK	Hallack, Minn.	50		WEVD	New York, N. Y.	500
	KLN	Oakland, Calif.	500		KGY	Lacey, Wash.	100		WHAP	New York, N. Y.	1000
	KPOF	Denver, Colo.	500		KMI	Pasco, Wash.	100		WHAZ	Troy, N. Y.	500
	WCOC	Columbus, Miss.	500		KOX	El Centro, Calif.	15		WIBW	Topeka, Kansas	1000
	WGBI	Scranton, Pa.	500		KPPC	Pasadena, Calif.	50	228.9	KFBK	Sacramento, Calif.	100
326.9	KFN	Shenandoah, Iowa	500		KSMR	Santa Maria, Calif.	100		KFGQ	Boone, Iowa	100
	KGJF	Little Rock, Ark.	250		KVOS	Bellingham, Wash.	100		KFIY	Fort Dodge, Iowa	100
	KUSD	Vermillion, S. D.	500		WABI	Bangor, Maine	100		KFLP	Dublin, Ohio	15
	WGST	Atlanta, Ga.	250		WABZ	New Orleans, La.	100		KFFM	Greenville, Texas	15
	WILL	Urbana, Ill.	250		WBBW	Norfolk, Va.	100		KFPD	Denver, Colo.	100
	WJAR	Providence, R. I.	250		WBBV	Charleston, S. C.	75		KFXJ	Edgewater, Colo.	50
	WMAZ	Macon, Ga.	250		WBBZ	Ponca City, Okla.	100		KFXR	Oklahoma City, Okla.	100
	WMMN	Fairmont, W. Va.	250		WCLO	Rapid City, S. D.	100		KGEZ	Kalispell, Mont.	100
333.1	KHJ	Los Angeles, Calif.	1000		WCEB	Kenosha, Wis.	100		KGHE	McGehee, Ark.	50
	KSEI	Pocatello, Idaho	250		WEPS	Gloucester, Mass.	100		KMED	Medford, Oregon	50
	WFBL	Syracuse, N. Y.	750		WFBC	Knoxville, Tenn.	50		KRMD	Shreveport, La.	50
	WFLA	Clearwater, Fla.	1000		WHBC	Canton, Ohio	10		KTSL	Shreveport, La.	50
	WKY	Oklahoma City, Okla.	1000		WHBY	West De Pere, Wis.	50		KWCR	Cedar Rapids, Iowa	100
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Wave (Meters)	Radio Call Letters	BROADCASTING STA. Location	Power (Watts)	Wave (Meters)	Radio Call Letters	BROADCASTING STA. Location	Power (Watts)	Wave (Meters)	Radio Call Letters	BROADCASTING STA. Location	Power (Watts)
	WFBG	Altoona, Pa.	100		KWKC	Kansas City, Mo.	100		WLBF	Kansas City, Mo.	100
	WFDL	Flint, Mich.	100		KZM	Oakland, Calif.	100		WLEY	Lexington, Mass.	100
	WFKD	Philadelphia, Pa.	50		WBBL	Richmond, Va.	100		WMBH	Detroit, Mich.	100
	WGAL	Lancaster, Pa.	15		WCBM	Baltimore, Md.	100		WMBH	Jordan, Mo.	100
	WGH	Newport News, Va.	100		WELK	Philadelphia, Pa.	100		WMRJ	Jamaica, N. Y.	10
	WHBP	Johnstown, Pa.	100		WFBJ	Collegeville, Minn.	100		WPOE	Patchogue, N. Y.	30
	WHBF	Cicero, Ill.	100		WGL	Fort Wayne, Ind.	100		WQBZ	Weirton, W. Va.	60
	WIBU	Poyntette, Wis.	100		WHBD	Bellevue, Ohio	100		WSSH	Boston, Mass.	100
	WJAK	Kokomo, Ind.	50		WHBO	Memphis, Tenn.	100		WTBO	Cumbersland, Md.	50
	WKAY	Laconia, N. H.	50		WHDF	Calumet, Mich.	100		WBAC	Harrisburg, Pa. (day)	500
	WKBB	Joliet, Ill.	100		WIBM	Jackson, Mich.	100		WBRL	Tilton, N. H.	500
	WKBI	Birmingham, Ala.	10		WJBK	Ypsilanti, Mich.	100		WCAH	Columbus, Ohio	500
	WKBS	Chicago, Ill.	50		WJBO	New Orleans, La.	100		WGBC	Memphis, Tenn.	500
	WKBS	Galesburg, Ill.	100		WMBQ	Auburn, N. Y.	100		WNBR	Memphis, Tenn.	500
	WLBC	Muncie, Ind.	50		WRBK	Erie, Pa.	50		KLS	Oakland, Calif. (day)	100
	WMBL	Lakeland, Fla.	100		WRBT	Wilmington, N. C.	50		WABO	Rochester, N. Y.	500
	WNAT	Philadelphia, Pa.	100		WVS	Buffalo, N. Y.	50		WBA	Allentown, Pa.	250
	WNBH	New Bedford, Mass.	100		WVSV	Pittsburgh, Pa.	500		WHEC	Rochester, N. Y.	500
	WNBJ	Knoxville, Tenn.	50	217.3	KOV	Clarinda, Iowa	1000		WMBD	Peoria, Ill.	500
	WORT	Union City, Tenn.	15		WCSO	Springfield, Ohio	500		WNRK	Greenboro, N. C.	250
	WRBW	Reading, Pa.	100		WKBH	LaCrosse, Wis.	1000		WOKO	Mt. Beacon, N. Y.	500
	WRBI	Hamilton, Ohio	100	215.7	KFPY	Spokane, Wash.	500		WSAN	Allentown, Pa.	250
	WSAJ	Grove City, Pa.	100		KLRA	Little Rock, Ark.	1000		WTAD	Quincy, Ill.	500
227.1	KID	Idaho Falls, Idaho	250		KOY	Phoenix, Arizona	500	206.8	KTBS	Shreveport, La.	500
	KGHF	Pueblo, Colo.	250		KUOA	Fayetteville, Ark.	1000		WBMS	Fort Lee, N. J.	250
	KGIO	Twin Falls, Idaho	250		KWSC	Pullman, Wash.	500		WFJC	Akron, Ohio	500
	WALDC	Akron, Ohio	1000		WDGY	Minneapolis, Minn.	500		WIBS	Elizabeth, N. J.	250
	WSMB	New Orleans, La.	500		WHDI	Minneapolis, Minn.	500		WKBO	Cleveland, Ohio	500
225.4	KSCJ	Sioux City, Iowa	1000		WHK	Cleveland, Ohio	1000		WNI	Newark, N. J.	250
	WDRC	New Haven, Conn.	500	214.2	KPWF	Westminster, Calif.	10000		WSAR	Portsmouth, R. I.	250
	WSAI	Cincinnati, Ohio	500		WBBC	Brooklyn, N. Y.	500		WTFI	Toccoa Falls, Ga.	250
	WTAQ	Tnshp. of Wash., Wis.	1000		WBCU	Brooklyn, N. Y.	500	205.4	KSTP	St. Paul, Minn.	10000
223.7	KFPW	Sulphur Spgs., Ark. (day)	50		WCM	Culver, Ind.	500		MT. Vernon Hills, Va.	10000	
	KMO	Tacoma, Wash.	500		WKB	Indianapolis, Ind.	500	204	KEJF	Oklahoma City, Okla.	5000
	KVI	Des Moines, Wash.	1000		WLTH	Brooklyn, N. Y.	500		KGA	Spokane, Wash.	5000
222.1	WSPD	Toledo, Ohio	500		WSDA	Brooklyn, N. Y.	500		WKBW	Buffalo, N. Y.	5000
	KWK	St. Louis, Mo.	1000		WSGH	Brooklyn, N. Y.	500		WRUF	Gainesville, Fla.	5000
	WBNY	New York, N. Y.	250	212.6	KFLV	Rockford, Ill.	500	202.6	WJAZ	Chicago, Ill.	5000
	WCDA	New York, N. Y.	250		KGRS	Amarillo, Texas	1000		WCKY	Villa Madonna, Ky.	5000
	WKBO	New York, N. Y.	250		WBCM	Hampton Tnshp., Mich.	500		WORD	Chicago, Ill.	5000
220.4	WMSG	New York, N. Y.	250		WIDAG	Amarillo, Texas	250		WSOA	Deerfield, Ill.	5000
	KFB	Harve, Mont.	250		WIBL	Sheboygan, Wis.	500	201.2	WBAW	Nashville, Tenn.	5000
	KGB	San Diego, Calif.	250	211.1	KPIF	Portland, Oregon	500		WLAC	Nashville, Tenn.	5000
	KGR	Butte, Mont.	250		KPIZ	Fond du Lac, Wis.	100	199.9	KDB	Santa Barbara, Calif.	100
	WGES	Chicago, Ill.	500		KFOU	Holy City, Calif.	100		KGDR	San Antonio, Calif.	100
	WJES	Gary, Ind.	500		KFOU	Seattle, Wash.	100		KGEI	San Angelo, Texas	100
	WLEX	Boston, Mass.	500		KFOW	Jerome, Idaho	50		KGHI	Little Rock, Ark.	100
	WMAF	South Dartmouth, Mass.	500		KFNY	Flagstaff, Arizona	100		KGHX	Richmond, Texas	50
218.8	WQBC	Utica, Miss.	300		KFOY	Abilene, Texas	100		KGKB	Brownwood, Texas	100
	KCRC	Enid, Okla.	100		KFOY	Vida, Montana	100		KPIJ	Prescott, Arizona	100
	KFB	Everett, Wash.	50		KGCK	Alva, Okla.	100		KUI	Longview, Wash.	15
	KFJL	Astoria, Oregon	50		KGFF	Los Angeles, Calif.	100		KWBS	Portland, Oregon	15
	KFJM	Grand Forks, N. D.	100		KGFJ	Ravenna, Neb.	50		KWTC	Santa Ana, Calif.	100
	KFJX	Fort Worth, Texas	100		KGGW	San Francisco, Cal.	50		WAFD	Detroit, Mich.	100
	KFLN	Galveston, Texas	100		KGIW	Trinidad, Colo.	100		WALK	Willow Grove, Pa.	50
	KGAR	Tucson, Arizona	100		KGIX	Las Vegas, Nev.	100		WCLB	Long Beach, N. Y.	500
	KGBX	St. Joseph, Mo.	100		KGKX	Sandpoint, Idaho	10		WHP	Harrisburg, Pa.	100
	KGCI	San Antonio, Texas	100		KOCW	Chickasha, Okla.	105		WKBV	Brookville, Ind.	100
	KGDA	Dell Rapids, S. D.	50		KORE	Eugene, Oregon	100		WKBZ	Ludington, Mich.	50
	KGER	Long Beach, Calif.	100		KTAP	San Antonio, Texas	100		WLBX	Long Island City, N. Y.	100
	KGFG	Oklahoma City, Okla.	100		KTUE	Houston, Texas	50		WLOE	Chelsea, Mass.	100
	KGFL	Raton, New Mexico	100		KVOA	Tucson, Ariz.	500		WMB	Newport, R. I.	100
	KGFM	Albuquerque, N. Mex.	100		KXRO	Seattle, Wash.	70		WMBQ	Brooklyn, N. Y.	100
	KGKI	San Angelo, Texas	100		WEDH	Erie, Pa.	35		WMES	Boston, Mass.	50
	KGRC	San Antonio, Texas	100		WHDL	Tupper Lake, N. Y.	10		WMPC	Lapeer, Mich.	100
	KIT	Yakima, Wash.	50		WHIS	Bluefield, W. Va.	100		WNSB	Binghamton, N. Y.	50
	KLO	Ogden, Utah	100		WIAS	Ottumwa, Iowa	100		WOPI	Bristol, Tenn.	100
	KOH	Reno, Nevada	100		WIBR	Steuernville, Ohio	50		WPSW	Philadelphia, Pa.	50
	KOHS	Marshallfield, Oregon	50		WILM	Wilmington, Del.	100		WRBJ	Hattiesburg, Miss.	10
	KRE	Berkeley, Calif.	100		WKB	Battle Creek, Mich.	50		WWRL	Woodsides, N. Y.	100
	KVL	Seattle, Wash.	100								

List of Canadian Broadcast Calls

(By Wavelengths)

556	CKX	Brandon, Man.	500		CNRO	Ottawa, Ont.	500	312	CFCV	Charlottetown, P. E. I.	100
517	CHCT	(See CKCL)			VAS	Louisburg, N. S.			CFRB	Toronto, Ont.	1000
	CHMA	Edmonton, Alta.	250	411	CHLS	(See CKCD)			CJBR	(See CKCK)	
	CHNC	(See CKNC)			CHYC	Montreal, Que.	750		CHCK	Charlottetown, P. E. I.	30
	CJBC	Toronto, Ont.			CKAC	Montreal, Que.	1200		CHWC	Regina, Sask.	500
	CJCA	Edmonton, Alta.	500		CKCD	Vancouver, B. C.	50		CJBC	Toronto, Ont.	500
	CJSC	(See CKCL)			CKFC	Vancouver, B. C.	50		CKCK	Regina, Sask.	500
	CKCL	Toronto, Ont.	500		CKMO	Vancouver, B. C.	100		CKGW	Bowmanville, Ont.	5000
	CKNC	Toronto, Ont.	500		CKWX	Vancouver, B. C.	100		CNRR	(See CKCK)	
	CKUA	Edmonton, Alta.	500		CNRM	(See CKAC)		297	CFLC	Prescott, Ont.	50
	CNRJ	(See CJCA)		334	CJCB	Sydney, N. S.	50		CKCR	Brantford, Ont.	50
500	CFCH	Iroquois Falls, Ont.	250		CKY	Winnipeg, Man.	5000		CKSH	St. Hyacinthe, Que.	1650
	CFBC	Quebec, Que.	25	357	CFCA	Toronto, Ont.	500	291	CJOR	Sea Island, B. C.	50
	CJRM	Moose Jaw, Sask.	500		CFCL	(See CKLC)			CNRM	(See CFCA)	
	CJRW	Fleming, Sask.	500		CJCB	Toronto, Ont.	1000		CNRV	Vancouver, B. C.	500
	CKCI	Quebec, Que.	23		CKLC	Red Deer, Alberta.		268	CFRC	Kingston, Ont.	500
	CKCV	Quebec, Que.	50		CKOW	(See CFCA)			CFR	Kamloops, B. C.	15
	CNRO	(See CKCV)		341	CHCS	Hamilton, Ont.	10		CHGS	Summerside, P. E. I.	25
476	CJGX	Victoria, B. C.	500		CHML	Mt. Hamilton, Ont.	50		CJOC	Lethbridge, Alta.	50
	CJRA	Moncton, N. B.	500		CKOC	Hamilton, Ont.	100		CKPR	Midland, Ont.	50
434	CFAC	Calgary, Alta.	500	337	CFBO	St. Johns, N. B.	50	248	CFCO	Chatham, Ont.	25
	CFCN	Calgary, Alta.	1800	329	CFOC	Saskatoon, Sask.	500		CFNB	Fredericton, N. B.	50
	CHCA	(See CJCA)			CJOG	London, Ont.	500		CFB	Chilliwack, B. C.	5
	CJCI	Calgary, Alta.	250		CJHS	Saskatoon, Sask.	250		CKMC	Cobalt, Ont.	15
	CKCO	Ottawa, Ont.	100	322	CNRS	(See CFQC)			CKPC	Preston, Ont.	25
	CNRC	(See CFAC)			CHNS	Halifax, N. S.	500				



Call Letters	BROADCAST STA. Location	Wave Length	Power (Watts)	Call Letters	BROADCAST STA. Location	Wave Length	Power (Watts)	Call Letters	BROADCAST STA. Location	Wave Length	Power (Watts)	
CANARY ISLANDS				YR				CYB				
EAR5	Las Palmas	250	200	Lyon		290	5000	CYC	Mexico City	275	500	
CEYLON				Agén		30.75		CYD	Vera Cruz	337	50	
	Colombo	800	1500	Beziers		180	500	CYD	Oaxaca	250	500	
CHILE				Biarritz		198	250	CYF	Mexico City	265	100	
CMAC	Santiago	360	1000	Bordeaux		419	1500	CYH	Monterrey	375	100	
CMAD	Santiago	320	1000	Fecamp		200		CYJ	Mexico City	400	2000	
CMAE	Santiago	280	100	Grenoble		416	150	CYL	Mexico City	400	500	
CMAI	Concepcion	345	1500	Juan-les-Pins		246	500	CYM	Torreon	225	1500	
CMAK	Temuco	245	100	Lille		246	500	CYO	Mexico City	425	100	
CMAO	Antofagasta	311	200	Limoges		285	500	CYQ	Tampico	322	100	
CMAT	Tacna	550	200	Marselles		300	1000	CYR	Mazatlan	475	250	
	Asuncion	12		Mont-de-Marsan		390	300	CYS	Monterrey	311	250	
	Valparaiso	400	50	Montpelier		238	200	CYU	Puebla	312	100	
CHINA				Nancy		15.5		CYX	Mexico City	325	500	
CEC	Tientsin	280	50	Nice		246		CYZ	Tampico	340	100	
COHB	Harbin	415		Nimes		249		CXE	Mexico City	350	500	
COMK	Mukden	425	2000	Paris		308	250	CZF	Chihuahua	310	250	
COTN	Tientsin	480	500	Paris		350		XEA	Guadalajara	250	10	
GOW	Victoria	300	1500	Rennes		294	1500	XES	Ciudad Lerdo	250		
KRC	Shanghai	342	250	Toulouse		389.6	2000	XFC	Jalapa	475		
RSC	Shanghai	342	250	GERMANY				XFF	Chihuahua	325		
VP33	Victoria	800		AB	Berlin	566	2000	MOROCCO				
XOL	Tientsin	480	500	AFT	Berlin	1648	8000	CNO	Casablanca	305	25	
	Shanghai	342	250	BMN	Bremen	387.1	1500		Rabat	414		
CHOSEN				HA	Hamburg	391.6	4000	NETHERLANDS				
JODK	Seoul	357	1000	KAV	Norddeich	1829		PCFF	De Bilt	1470	1250	
CUBA				LA	Langenberg	462.2	25000	PCLL	Kootwijk	184	25,000	
CMC	Havana	347	500	LP	Frankfort-on-the-Main	421.3	4000	HDO	Hilversum	1060	1000	
PWH	Havana	376	500	MR	Leipzig	361.9	4000		Scheveningen	187.5	2500	
IAZ	Guantanamo	275	30	MS	Muenster	265.5	1500		Huizen	340.9	1840	
2AB	Havana	250	10	OKP	Stuttgart	374.1	4000	NETHERLANDS EAST INDIES				
2AZ	Havana	334	30	SMXQ	Cologne	263.2	4000		Soerabaya	90		
2BB	Havana	250	15		Aix-la-Chapelle	455.9	750	NEW ZEALAND				
2CP	Havana	280	10		Augsburg	566	700	1YA	Auckland	420	500	
2FG	Hershey	226	20		Berlin	438.9	800	1YC	Whangerei	250	15	
2HP	Havana	252	15		Berlin	475.4	4000	1ZB	Auckland	275		
2JP	Havana	245.5	15		Berlin	2525	5000	1ZQ	Auckland	253		
2JL	Mariano	294	7 1/2		Breslau	321.2	5000	2YA	Wellington	420	5000	
2LC	Havana	303	30		Danzig	272.7	750	2YK	Wellington	295	60	
2MA	Mariano	277	50		Dortmund	283	750	2ZA	Wanganui	500		
2OH	Havana	284	20		Dresden	387.1	700	2ZM	Gisborne	260	500	
2OK	Havana	350	100		Elberfeld	468.8	750	3AC	Christchurch	400	500	
2OL	Havana	257	100		Flensburg	219	750	3YA	Christchurch	306	500	
2RK	Havana	326	50		Freiburg im Breisgau	577	750	4YA	Dunedin	380	110	
2SE	Havana	211	10		Gleiwitz	326.4	750	4ZB	Otago	300		
2SW	Havana	224	7 1/2		Hanover	566	750	4ZL	Dunedin	252		
2TW	Havana	270	30		Kaiserlautern	204.1	4000	4ZM	Dunedin	277.8		
2UF	Havana	228	100		Kassel	250	750	2ZF	Palmerston	280		
2WX	Havana	261	150		Kiel	250	750	NORWAY				
2XA	Havana	230	200		Koenigsberg	280.4	4000	OSLO	Oslo	270.4	1500	
2XX	Havana	275	10		Munich	546.7	4000		Aalesund	511		
SDW	Matanzas	275	10		Nuremberg	240	4000		Bergen	370.4		
SEV	Colon	360	100		Schoerbeeck	230			Bergen	370.4	1500	
6BY	Cienfuegos	260	200		Stettin	236.2	500		Fredrikstad	434.8	750	
6EV	Caibarien	250	50	HAITI					Natodden	411	700	
6HS	Sagua la Grande	200	10	HHK	Port-au-Prince	361.2	1000		Porsgrund	405	1000	
6JO	Cienfuegos	275	10		HAWAII					Rjukan	447.8	250
6KC	Cienfuegos	240	10	KGU	Honolulu	270.1	600		Stamanger	277.6	1500	
6KP	Sancti Spiritus	280	20	KGHB	Honolulu	227.1	250	PERU				
6KW	Tuinieu	368	100	HUNGARY				OAX	Lima	360	1500	
6LO	Caibarien	325	250	MT1	Budapest	555.6	2000	PHILIPPINE ISLANDS				
6MN	Santa Clara	210	20	MT2	Budapest	1050	400	KPM	Iloilo	400	500	
6XJ	Tuinieu	200	20	MT3	Budapest		12000	KZIB	Manila	260	500	
7AZ	Camaguey	225	10	ICELAND				KZRQ	Manila	385	1000	
7BY	Ciego de Avila	235	20	G2SH	Akureyri	192		POLAND				
7EV	Camaguey	190			Reykjavik	333.3	500	AXO	Warsaw	1111.1	8000	
7FU	Ciego de Avila	200	15	INDIA					Katowice	422	2000	
7GT	Camaguey Armanda Vaquer	192	5	2AX	Bombay	320	50		Krakow	422	1300	
7HS	Ciego de Avila	193	15	2FY	Bombay	387	100		Poznan	270.3	1500	
7IR	Ciego de Avila	193	15	2GR	Madras	400	200		Wilna	435		
7LO	Camaguey	230	20	2HZ	Rangoon	350	40	PORTO RICO				
7NM	Nuevitos	264	20	7BY	Bombay	357.1	3000	WKAQ	San Juan	322.4	500	
7SR	Elia	350	300	7CA	Calcutta	370.4	4000	PORTUGAL				
8BY	Santiago	200	30	VUB	Bombay	357.1		PIAA	Lisboa	305	500	
8HS	Santiago	190	20	VUC	Calcutta	370.4		ROUMANIA				
8IR	Santiago	180	100	VPB	Colombo	800			Bucharest	401.6		
8KP	Caney	250	15	IRISH FREE STATE				SAN SALVADOR				
8KW	Santiago	250	15	2RN	Dublin	319.1	1500	AQM	San Salvador	482	500	
8LC	Caney	300	100	6CK	Cork	400	1000	SENEGAL				
CZECHOSLOVAKIA				ITALY				SPAIN				
OKB	Brunn	441.2	2400	IIAX	Rome	45		EAJ1	Barcelona	344.8	1000	
OKK	Kosice	263	2000	IMI	Milan	315.8	7000	EAJ2	Madrid	416.1	600	
OKP	Prague	384.9	5000	INA	Naples	333.3	1500	EAJ3	Cadiz	400	1000	
OKR	Bratislava	300	500	IRO	Rome	449	3000	EAJ7	Madrid	375	1200	
	Kosice	1870			Genoa	6000		EAJ8	San Sebastian	297	3000	
DENMARK				JAPAN				EAJ9	Bilbao	434.8	1000	
	Copenhagen	339.8	1000	JOAK	Tokyo	375	1000	EAJ13	Barcelona	462	1000	
	Kalundborg	1535	750	JOBK	Osaka	385	1000	EAJ16	Cartagena	330	1000	
	Ryvang	1150	1000	JOCK	Nagoya	360	1000	EAJ17	Seville	434.8	600	
	Soro	1153.8	1500	JODK	Keijo	357	1000	EAJ18	Almeria	320	1000	
DUTCH EAST INDIES				JOJK	Hiroshima	353	10000	EAJ19	Oviedo (Cina)	280.4	200	
ANE	Bandoeng	310	6	JOJK	Kumamoto	380	2000	EAJ22	Salamanca	500	500	
ANH	Malabor			JOHK	Sandai	390	1000	EAJ25	Malaga	100	100	
JFC	Batavia	220.7	40	JOIK	Sapporo	361	1000	STRAITS SETTLEMENTS				
	Surabaya	140	500	KENYA				ISE	Singapore	330	100	
	Surabaya	175		7LO	Nairobi	35		SWEDEN				
EGYPT				JQAK	Dairen	395	5000	SASA	Stockholm	454.5	1000	
SRE	Cairo	225		LATVIA				SASB	Goteborg	416.1	600	
ESTHONIA				KCX	Riga	526.3	2000	SASC	Malmo	260.9	600	
	Tallinn	408	700	LITHUANIA				SASD	Sundsvall	545.6	600	
	Tallinn	1200	100	Kuanas		2000		SASE	Boden	1190	600	
FINLAND				Kovno		2000		SASF	Ostersund	720	600	
3NB	Tammerfors (Tampere)	400	250	LUXEBURG				SASG	Motala	1380	30000	
	Bjorneborg	254.2	100	LOAA	Luxemburg	217.4	250	SMRM	Uppsala	500	150	
	Helsingfors	500	1000	MEXICO				SMSB	Halmstad	215.8	200	
	Helsingfors	240	2000	CYA	Mexico City	300	500	SMSL	Hudiksvall	272.7	160	
	Jacobstad (Pietersariki)	275	200	MEXICO				SMSM	Karlskrona	196	200	
	Jyvaskyla	297	200					SMSN	Umea	229	200	
	Lahtis	1525	40,000					SMSO	Varberg	297	300	
	Lahtis	318	180					SMTG	Kiruna	238.1	400	
	Mikeli	566	250					SMTI	Orebro	236.2	200	
	Uleaborg	250	250					SMTJ	Kristinehamn	202.7	250	
	Viborg	240	750					SMTS	Safla	252.1	400	
FRANCE				LATVIA				SMUC	Eskilstuna	250	200	
2BD	Agén	297	500	KCX	Riga	526.3	2000	SMUW	Linkoping	500	200	
5NG	Paris	340.9	500	LITHUANIA				SMVU	Norkoping	275.2	250	
8AJ	Paris	1780	100	Kuanas		2000		SMXF	Gavle	204.1	200	
8GF	Strasbourg	222.2	250	Kovno		2000						
F8GC	Paris	350	500	LUXEBURG								
CFR	Paris	1750	3000	LOAA	Luxemburg	217.4	250					
FL	Paris	458	1000	MEXICO								
FPTT	Paris	238	200	CYA	Mexico City	300	500					
MRD	Toulouse	260	1000									
YN	Lyon	480	1000									

THIS listing of foreign broadcast stations of the world, up to the present listing, is correct, although undoubtedly some changes will be made after going to press. In many cases, reliable information about programs, wave length and power of the stations cannot be obtained even from the stations themselves.

Call Letters	BROADCAST STA. Location	Wave Length	Power (Watts)	Call Letters	BROADCAST STA. Location	Wave Length	Power (Watts)	Call Letters	BROADCAST STA. Location	Wave Length	Power (Watts)
SMXG	Karlstad	220.6	250	RA11	Tiflis	870	4000	2DE	Dundee	294	200
SMXO	Molmberg	400	250	RA12	Voronezh	950	240	2EH	Edinburgh	288.5	500
SMXQ	Trollhattan	278.8	400	RA13	Nizhni-Novgorod	840	1800	2LO	London	297	200
SMYB	Boras	240.8	150	RA14	Rostov-on-Don	820	4000	2LS	Leeds	277.8	500
SMYA	Helsingborg	229	200	RA15	Sverdlovsk	1050	500	2LS	Bradford	252.1	200
SMZA	Ornskoldsvik	222.2	200	RA16	Vel' Ust'ug	620	1200	2NM	Catherham	32.5	50
SMZD	Jonkopings	201.3	250	RA17	Vladivostok	480	1500	2ZY	Manchester	384.6	1500
SMZK	Falun	345.3	500	RA18	Minsk	860	1200	5GB	Daventry	323.2	25000
SMZP	Uddevalla	294.1	500	RA20	Stavropol	550	1200	5IT	Birmingham	326.1	1500
	Hamar	555.8	—	RA21	Tomsk	300	150	5NG	Nottingham	275.2	200
SWITZERLAND				RA22	Samara	900	1200	5NO	Newcastle	312.5	1500
HBA	Berne	407	1500	RA25	Orenburg	640	1000	5PY	Plymouth	400	200
HBI	Geneva	760	500	RA26	Astrakhan	700	1000	5SC	Glasgow	405.4	1500
HBZ	Zurich	500	1500	RA27	Tashkent	751	2000	5SW	Daventry	24	200
HB2	Lausanne	850	600	RA30	Dnepropetrovsk	525	1000	5SX	Swansea	294	200
HB3	Basel	1000	300	RA32	Novosibirsk	1117	4000	5WA	Cardiff	353	1500
TUNISIA				RA33	Saratov	420	200	5XX	Daventry	1600	16000
TNU	Carthage	1850	5000	RA34	Koursk	575	1000	6BM	Bournemouth	491.8	1500
TUA	Tunis	1450-45	100	RA38	Krasnodar	513	1000	6FL	Sheffield	272.7	200
8KR	Constantine	42.8	—	RA39	Gomel	925	1200	6KH	Hull	294	200
TURKEY				RA40	Odessa	975	1200	6LV	Liverpool	297	200
	Angora	1806	6000	RA41	Volgoda	875	1200	6ST	Stoke-on-Trent	294	200
	Osmamieh	1200	6000	RA42	Leningrad	1000	10000	6SW	Chelmsford	24	200
	Stamboul	1200	15000	RA43	Kharkov	475	1700	URUGUAY			
UNION OF SOUTH AFRICA				RA44	Tver	690	1200	CWOA	Montevideo	428.4	1000
JB	Johannesburg	42	900	RA45	Kiev	775	1200	CWOF	Montevideo	300	100
WAMG	Capetown	443.5	900	RA46	Baku	750	4000	CWOG	Montevideo	280	10
	Durban	372	1200	RA47	Petrozavodsk	765	2000	CWOH	Montevideo	300	50
	Pretoria	323	1200	RA49	Armavir	720	200	CWOI	Salta	272	50
UNION OF SOVIET SOCIALIST REPUBLICS (Formerly Russia)				RA51	Erivan	1050	1200	CWOJ	Salta	250	10
RA1	Moscow	1450	40000	RA55	Ulyanovsk	500	20	CWOK	Montevideo	260	50
RA2	Moscow	450	500	RA56	Artemovsk	700	1200	CWOL	Montevideo	272	100
RA4	Moscow	450	300	RA57	Irkutsk	1100	500	CWOM	Montevideo	265.5	20
RA7	Ivanova-Vosnensensk	800	180	RA59	Leningrad	150	350	CWON	Montevideo	294	50
RA8	Bogorodsk	750	700	RA64	Petrozavlovsk	350	45	CWOO	Montevideo	294	50
RA9	Sevastopol	900	250	RA67	Nalchik	1070	240	CWOR	Montevideo	350	500
				RA68	Smolensk	330	20	CWOS	Montevideo	380	500
				RA72	Smolensk	150	800	CWOW	Montevideo	500	500
				RA77	Stalino	730	1200				
				RDW	Moscow	1450	12000				
UNITED KINGDOM				UNITED KINGDOM				VENEZUELA			
2BD	Aberdeen	500	1500	2BD	Aberdeen	500	1500	AYRE	Caracas	375	1000
2BE	Belfast	306.1	1500	2BE	Belfast	306.1	1500	YUGOSLAVIA			
								Zagreb	309.2	100	

Foreign Radio Broadcast Stations, Including U. S. Possessions By Wave-Lengths

Wave Length (Meters)	Call Letters	COUNTRIES AND CITIES	Power (Watts)	Wave Length (Meters)	Call Letters	COUNTRIES AND CITIES	Power (Watts)	Length (Wave Meters)	Call Letters	COUNTRIES AND CITIES	Power (Watts)
399.8	KGBU	Ketchikan	500	300		BOLIVIA	50	277	2MA	Mariano	50
344.8	KFQD	Anchorage	100	175		La Paz	50	275	1AZ	Guanajay	30
225.4	KFIU	Juneau	10			La Paz	50		2XX	Havana	10
ALGERIA				BRAZIL					6JO	Cienfuegos	10
310	8DB	Algiers	100	600	SKV	Bahia	50	274	2SW	Mariano	75
ARGENTINA				445	SQAD	Bahia	50	270	2TW	Havana	30
425	LOP	La Plata	1000	425	SQAA	Sorocaba	50	264	7NM	Matanzas	20
400	LOT	Buenos Aires	1000	400	RSR	Rio de Janeiro	2000	261	2WN	Nuevitas	150
380	LOX	Buenos Aires	1000	381	SQAY	Porto Alegre	200	260	6BY	Cienfuegos	200
361.5	LOV	Buenos Aires	1000	380	SQAY	Porto Alegre	200	257	2OL	Havana	10
348	M6	Mendoza	10	350	SQAG	Sao Paulo	1000	250	2JF	Mariano	15
344.8	LOR	Buenos Aires	1000	310	SQAB	Rio de Janeiro	500	248	2AB	Havana	10
330	LOZ	Buenos Aires	1000			Pernambuco	500	246	2BB	Havana	15
315.2	LOY	Buenos Aires	1000	280	SQAI	Santos	10	245.5	2JP	Caibarien	50
303	LOW	Buenos Aires	1000	260	SQAJ	Rio de Janeiro	500	240	6KC	Santiago	15
291.2	LOS	Buenos Aires	5000	240	SQAF	Curytiba	8	235	7BY	Ciego de Avila	20
280	LOU	Mendoza	500	225.4	SQBO	Sao Paulo	1000	230	2XA	Havana	200
279	F1	Santo Fe	30	24		Para	34	228	7LO	Camaguey	20
275	H5	Cordoba	100			Bahia	34	226	2UF	Havana	100
275	H2	Buenos Aires	100					225	2PG	Hershey	20
270	F2	Rosario	100					225	7AZ	Camaguey	10
261.8	LOJ	Buenos Aires	1000	350	EARS	CANARY ISLANDS	200	211	2SE	Havana	10
253.3	D3	Buenos Aires	3000	250				210	6MN	Santa Clara	20
252	LOO	Buenos Aires	100					205	2HP	Havana	200
236	LOI	Buenos Aires	2000	550	CMAT	CHILE	200	200	6YS	Sagua la Grande	10
210	LON	Buenos Aires	5000	400	CMAC	Valparaiso	50	195	7FU	Ciego de Avila	15
AUSTRALIA				360	CMAC	Santiago	1000	193	7TR	Santiago	30
1250	6WF	Perth	1000	345	CMAD	Concepcion	1500	192	7HS	Camaguey Armada Vaquer	5
484	3AR	Melbourne	320	320	CMAD	Santiago	1000	190	7EV	Ciego de Avila	15
464	2WA	Sydney	100	280	CMAD	Santiago	100	180	8KR	Santiago	20
442	2FC	Sydney	2000	245	CMAD	Teneco	100	150	8BY	Caney	100
392	5CL	Adelaide	1000	12	CMAD	Antofagasta	100			Santiago	30
385	4QG	Brisbane	1000					CHINA			
371	3LO	Melbourne	1000	800	VPS3	Victoria	500	1870		CZECHOSLOVAKIA	
353	2BL	Sydney	1000	480	COTN	Tientsin	500	441.2	OKB	Kosice	2400
337	4MB	Brisbane	250			Tientsin	500	384.9	OKP	Brunn	5000
326	2BE	Sydney	20	445	COHB	Harbin	2000	300	OKR	Bratislava	500
323	4RN	Sydney	1500	425	COMK	Mukden	250	263	OKK	Kosice	2000
319	3UZ	Rockhampton	100	342	RSC	Shanghai	250			DENMARK	
313	4DN	Shanghai	100			Shanghai	250	1535		Kalundborg	7500
303	3WR	Melbourne	20	300	GOW	Victoria	1500	1153.8		Soro	1500
297	2VE	Melbourne	50	280	CEC	Tientsin	50	1150		Ryvang	1000
294	4GR	Toowoomba	20					339.8		Copenhagen	1000
288	2HD	Newcastle	20	CHOSEN				DUTCH EAST INDIES			
286	3EO	Mildura	20	357	JODK	Seoul	1000	310	ANE	Bandoeng	6
280	2KV	Sydney	300					220	JFC	Batavia	40
278	4CM	Brisbane	50					140		Surabaya	500
275	2MK	Bathurst	250						ANH	Malabor	500
263	2UW	Northbridge	100					EGYPT			
AUSTRIA								225	SRE	Cairo	—
577		Vienna	14000					ESTONIA			
517.2	ORV	Vienna	500					1200		Tallinn	100
365.8		Graz	500					408		Tallinn	700
294.1		Innsbruck	500					FINLAND			
272.7		Klagenfurt	500					1525		Laitis	40000
254.2		Linz	500					566		Mikeli	250
BELGIUM								500		Helsingfors	1000
508.5	BAV	Brussels	1500								
294.1		Liege	100								
275		Ghent	100								
265.5		Antwerp	100								
230		Brussels	100								
205		Liege	100								

Wave Length (Meters)	Call Letters	COUNTRIES AND CITIES	Power (Watts)	Wave Length (Meters)	Call Letters	COUNTRIES AND CITIES	Power (Watts)	Wave Length (Meters)	Call Letters	COUNTRIES AND CITIES	Power (Watts)	
400	3NB	Tammerfors (Tampere)	250			LUXEMBURG		294.1	SMZP	Uddevalla	500	
318		Lahiti	180	217.4	LOAA	Luxemburg	250	278.8	SMZQ	Trohattan	400	
297		Jyväskylä	200			MEXICO		275.2	SMVU	Norkoping	250	
275		Jacobstad (Pietersariki)	200					272.7	SMSL	Hudiksvall	150	
254.2		Bornborg	100	549	CYY	Merida	100	260.9	SASC	Malmö	600	
240		Uleaborg	250	475	CVR	Mazatlan	250	252.1	SMTS	Säffe	600	
		Helsingfors	2000					250	SMUC	Eskilstuna	200	
		Viborg	750	425	XFC	Jalapa	100	238.1	SMTG	Kiruna	400	
		FRANCE		400	CYO	Mexico City	2000	236.2	SMTI	Örebro	200	
1780	8AJ	Paris	100					230.8	SMVB	Boras	200	
1750	CRF	Paris	3000	375	CYH	Mexico City	100	229	SMSE	Umeå	200	
480	YN	Lyon	1000	350	CXE	Mexico City	500	222.2	SMZA	Helsingborg	200	
458	FL	Bordeaux	1500	337	CYC	Veracruz	50	220.6	SMXG	Ornskoldsvik	200	
419		Grenoble	150	325	CYK	Chihuahua	500	215.8	SMXB	Karlstad	250	
390		Mont-de-Marsan	300	300	CYF	Tampico	100	204.1	SMXF	Halmstad	200	
389.6		Toulouse	2000	311	CYU	Monterrey	250	202.7	SMTI	Kristinehamn	250	
350		Paris	500	310	CZF	Chihuahua	250	201.3	SMZD	Jonkopings	250	
340.9	SNG	Paris	500	300	CYA	Mexico City	500	196	SMSM	Karlskrona	200	
308		Marseilles	1000	275	CYB	Mexico City	500			SWITZERLAND		
297	2BD	Agén	500	265	CYF	Oaxaca	100	1000	HB3	Basel	300	
294		Rennes	1500	250	CYD	Veracruz	500	850	HB2	Lausanne	600	
290	YR	Lyon	5000		NEA	Guadalajara	10	760	HBI	Geneva	500	
285		Limoges	500	225	NES	Ciudad Lerdo	1500	500	HBZ	Zurich	1500	
267.3		Lille	500	20	CYZ	Tampico	20	407	HBA	Berne	1500	
260	MRD	Toulouse	1000			MONTEVIDEO				TUNISIA		
249		Nîmes	500	414		MOROCCO		1850	TUN	Carthage	5000	
246		Juan-les-Pins	500	305	CNO	Rabat	25	1450	TUA	Tunis	100	
245		Nice	200					42.8	SKR	Constantine	100	
238	FPTT	Paris	200	1875		NETHERLANDS		1806		TURKEY		
222.2	SGF	Strasbourg	250	1840				1200		Angoria	6000	
200		Montpellier	200	1470	PCFF	Scheveningen	2500	443.5	JB	Osmanieh	6000	
198		Biarritz	250	1060	HDO	De Bilt	1250	372	WAMG	Stambul	15000	
180		Beziers	500	340	PCLL	Hilversum	1000	323		UNION OF SO. AFRICA		
		GERMANY		184				32	JB	Johannesburg	900	
2525		Berlin	5000			NETHERLANDS EAST INDIES				Capetown	1200	
1829	KAV	Norddeich	8000	90						Johannesburg	900	
1648	AFT	Breilburg im Breisgau	750			NEW ZEALAND				UNION OF SOVIET SOCIALIST REPUBLICS (Formerly Russia)		
577	AB	Berlin	2000	500	2ZA	Wanganui	1700	1700	RA43	Kharkov	4000	
566		Augsburg	700	420	1YA	Auckland	500	1450	RA1	Moscow	40000	
		Hanover	750						RDW	Moscow	500	
536		Munich	4000	400	2YA	Wellington	5000	1117	RA32	Novorossiisk	4000	
475.4		Berlin	4000	380	3AC	Christchurch	110	1100	RA57	Irkutsk	500	
468.8	LA	Elberfeld	750	300	4YA	Dunedin	110	1070	RA59	Nalchik	240	
462.2		Langenberg	25000	300	4ZB	Otago	1000	1050	RA49	Erivan	1200	
455.9		Aix-la-Chapelle	800	295	2YK	Wellington	60	1000	RA42	Leningrad	10000	
438.9		Frankfort-on-the-Main	4000	280	2ZF	Palmerston	950	975	RA40	Odessa	1200	
421.3	1P	Frankfort-on-the-Main	4000	277.8	4ZM	Dunedin	700	950	RA12	Voronezh	240	
391.6	HA	Hamburg	4000	275	1ZB	Auckland	700	925	RA9	Saratov	1200	
387.1		Dresden	700	260	2ZM	Gisborne	500	900	RA22	Samara	1200	
	BMK	Bremen	1500	253	1ZQ	Auckland	50	875	RA41	Vologda	1200	
374.1	OKNP	Stuttgart	4000	252	4ZL	Dunedin	15	870	RA11	Tiflis	4000	
361.9	MR	Leipzig	4005	250	1YC	Whangarei		860	RA18	Minsk	1200	
326.4		Gleiwitz	750	511		NORWAY		840	RA13	Nizhni-Novgorod	1800	
321.2		Breslau	5000	500	500			820	RA14	Rostov-on-Don	4000	
283		Dortmund	750	447.8	447.8	Aalesund		800	RA7	Ivanova-Vosnensensk	180	
280.4		Koenigsberg	4000	434.8	434.8	Tromso		790	RA56	Artemovsk	1200	
272.7		Danzig	1500	411	411	Rjukan	250	775	RA55	Kiev	1200	
265.6	MS	Muenster	4000	370.4	OSLO	Fredrikstad	750	765	RA46	Petrozavodsk	2000	
263.2	SMNQ	Cologne	4000	405		Natodden	700	751	RA27	Tashkent	200	
250		Kassel	750	252		Porsgrund	1000	750	RA8	Bogorodsk	700	
240		Nuremberg	4000	250		Bergen	1500		RA45	Baku	4000	
236.2		Stettin	500	277.6		Bergen	1500	730	RA77	Stalino	1200	
230		Schoerbeck	500	243.9		Stavanger	1500	720	RA47	Armavir	200	
219		Flensburg	4000			Trondhjem	1000	700	RA26	Astrakhan	1000	
204.1		Kaiserlautern	4000	360	OAX			690	RA44	Fev	4000	
		HAITI				PHILIPPINE ISLANDS		640	RA25	Orenburg	1000	
361.2	HHK	Port-au-Prince	1000	400	KPM	Iloilo	500	620	RA16	Vel Ustjuk	1200	
		HAWAII		385	KZRO	Manila	1000	575	RA34	Koursk	1000	
270.1	KGU	Honolulu	600	270	KZKZ	Manila	500	550	RA20	Stavropol	1200	
227.1	KGHB	Honolulu	250	260	KZIB	Manila	500	525	RA30	Dniepropetrovsk	1000	
		HUNGARY				POLAND		513	RA38	Krasnodar	1000	
1050	MT2	Budapest	400	1111.1	AXO	Warsaw	8000	480	RA51	Ulyanovsk	20	
555.6	MT1	Budapest	2000	435	435	Wilna		475	RA43	Vladivostok	1500	
	MT3	Budapest	12000	422	422	Katowice	2000	450	RA2	Moscow	500	
		ICELAND		270.3		Krakow	1300	420	RA4	Moscow	500	
333.3		Reykjavik	500			Poznan	1500	350	RA32	Saratov	200	
192	G2SH	Akureyri	500			PORTO RICO		330	RA64	Petrovavlavsk	45	
		INDIA						300	RA68	Smolensk	20	
800	VPB	Colombo		322.4	WKAQ	San Juan	500	300	RA21	Tomsk	150	
400	2GR	Martara	200			PORTUGAL		150	RA72	Smolensk	800	
387	2BV	Bombay	100						RA59	Leningrad	350	
370.4	7CA	Calcutta	3000	305	PIAA	Lisbon	500	1600	5NX	UNITED KINGDOM		
	VUC	Calcutta						500	2BD	Daventry	16000	
357.1	7BY	Bombay	3000	401.6		ROUMANIA		491.8	6BM	Aberdeen	1500	
	VUB	Bombay						405.4	5SC	Bournemouth	1500	
350	2HZ	Rangoon	40	482	AQM	Bucharest	500	400	5PY	Glasgow	1500	
320	2AX	Bombay	50			SAN SALVADOR		384.6	2ZY	Plymouth	200	
		IRISH FREE STATE						353.1	5WA	Manchester	1500	
400	6CK	Cork	1000	300		SENEGAL		326.1	5TG	Cardiff	1500	
319.1	2RN	Dublin	1500					323.2	5GB	Birmingham	1500	
		ITALY						312.5	5NO	Daventry	25000	
449	1RO	Rome	3000	500	EAJ22	Salamanca	500	306.1	2BE	Newcastle	1500	
333.3	1NA	Naples	1500	462	EAJ13	Barcelona	1000	297	6LV	Belfast	1500	
315.8	1MI	Milan	7000	434.8	EAJ19	Barcelona	1000	294	21O	Liverpool	200	
45	1HAX	Genoa	6000		EAJ17	Seville	600		21E	London	200	
		JAPAN			420	EAJ2	Madrid	600	5SY	Dundee	200	
390	JOHK	Sandai	1000		400	EAJ3	Cadiz	1000	6KH	Swansea	200	
385	JOBK	Osaka	1000		375	EAJ7	Madrid	1200	6ST	Hull	200	
380	JOJK	Kumamoto	2000		344.8	EAJ1	Barcelona	1000	2EH	Stroke-on-Trent	200	
370	JOJK	Tokyo	1000		330	EAJ16	Cartagena	1000	277.8	2LS	Edinburgh	500
361	JOJK	Sapporo	1000		320	EAJ18	Almeria	1000	275.2	5NG	Leeds	500
360	JOJK	Nagoya	1000		297	EAJ8	San Sebastian	1000	272.7	6FL	Nottingham	200
357	JODK	Keijo	1000		280.4	EAJ19	Oviedo (Cima)	200	252.1	2LS	Sheffield	200
353	JOJK	Hiroshima	10000		100	EAJ25	Malaga	100	32.5	2NM	Bradford	200
		KENYA				STRAITS SETTLEMENTS		24	5SW	Caterham	200	
400	7LO	Nairobi		330	1SE	Singapore	100		6SW	Daventry	1000	
35		KWANTUNG				SWEDEN		500	CWOW	Chelmsford	1000	
395	JQAK	Dairen	5000	1380	SASG	Motala	30000	428.4	CWAO	Montevideo	1000	
		LATVIA		1190	SASE	Boden	600	380	CWOR	Montevideo	500	
526.3	KCN	Riga	2000	720	SASF	Ostersund	600	350	CWOF	Montevideo	100	
		LITHUANIA		545.6				300	CWOH	Montevideo	50	
2000				500				294	CWOJ	Montevideo	50	
				454.5	SASD	Sundsvall	600	280	CWOG	Montevideo	100	
				500	SMRU	Uppsala	150	272	CWOL	Montevideo	50	
				454.5	SASA	Linkoping	200	265.5	CWOM	Montevideo	20	
				416.1	SASB	Stockholm	1000	260	CWON	Montevideo	50	
				400	SMXO	Goteborg	600	256.5	CWOJ	Montevideo	10	
				335.3	SMZK	Molnberg	250	250	CWOJ	Montevideo	200	
				297	SMZO	Falun	250			VENEZUELA		
						Varberg	300	375	AYRE	Caracas	1000	
								369.2		YUGOSLAVIA		

of the set under test.

The tone of the oscillator will then be audible in the loud speaker. When it has been peaked carefully by tuning the receiver dial, make note of the scale reading. Then shift the clip from antenna post to the plate terminal of the first radio-frequency tube socket, retune the receiver, and again note the dial setting.

Repeating this process with each radio frequency stage, that one that is off resonance can quickly be detected, and correction made so that, regardless of the position of the clip, settings of the receiver dial are uniform.

Reversing the procedure just outlined, the oscillator can be calibrated by tuning the set to a known broadcasting station, then putting the oscillator in resonance with the receiver, and noting the oscillator dial setting.

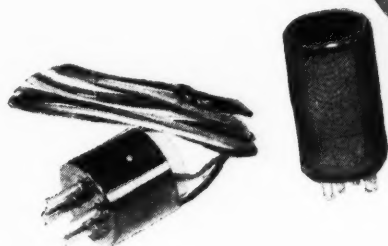
Suppose that the station is WLW, Cincinnati, which broadcasts on 700 kilocycles, and that the oscillator dial reads 60. Then this setting will always correspond to 700 kilocycles, and stations in that channel will be picked up by tuning a receiver to the oscillator when its dial is at 60.

After several stations at various points in the broadcast band have been logged on the multi-unit when it is used as an oscillator, it will function as a wave-meter. And if a graph be prepared with its curve running through the plotted positions of these stations, the places at which others should come in can be determined quite accurately.

It might happen, for example, that a new receiver was being tried out for DX, and that its dial was not sufficiently accurate to make sure of KFI's presence or absence. With the oscillator set at 640 kilocycles and the receiver tuned to it, Los Angeles would be heard if within range, after the oscillator had been shut off.

For portability and convenience, the unit can be powered as a radio-frequency oscillator by a $4\frac{1}{2}$ volt "C" battery light-

Here is the multi-unit ready for short-wave reception. The broadcast coil, fitted with a standard four-prong base, is to the left as is the cable-plug for use in connecting the unit as a short-wave adapter



ing the filament of a 199 tube, and a 22 or 45-volt "B" battery for plate supply.

Such are only two of the many uses for the radio-frequency oscillator into which this unit can be so easily converted.

Short-circuiting the grid leak and condenser, as shown by a dotted line in the diagram, Fig. 3, gives an unmodulated note for special purposes. Another range control is the fixed condenser that can be cut into or out of the tuning circuit.

The result of using the multi-unit as a pre-amplifier or booster with a broadcast set is, naturally, increased range, selectivity and volume. The device then serves as an additional stage of radio-frequency, with or without regeneration.

The operation is the very simple one of plugging into the first radio-frequency

A Handy R. F. Amplifier or Short-Wave Adapter

socket of the receiver, then tuning the unit dial with those of the set.

Of particular interest is such employment of the multi-unit by owners of sets of the older vintage, with good amplifiers and speakers, but perhaps only a stage or two of radio-frequency instead of the three or four that are common now.

The logical thing, then, is to add a stage, and since putting it inside the cabinet would be difficult if not impossible, a small external unit that is easy to connect and tune is the thing. And the multi-unit makes use not only of standard radio-frequency tubes, but the more efficient screen-grid types as well. To facilitate the extra connection, a tube cap clip is provided.

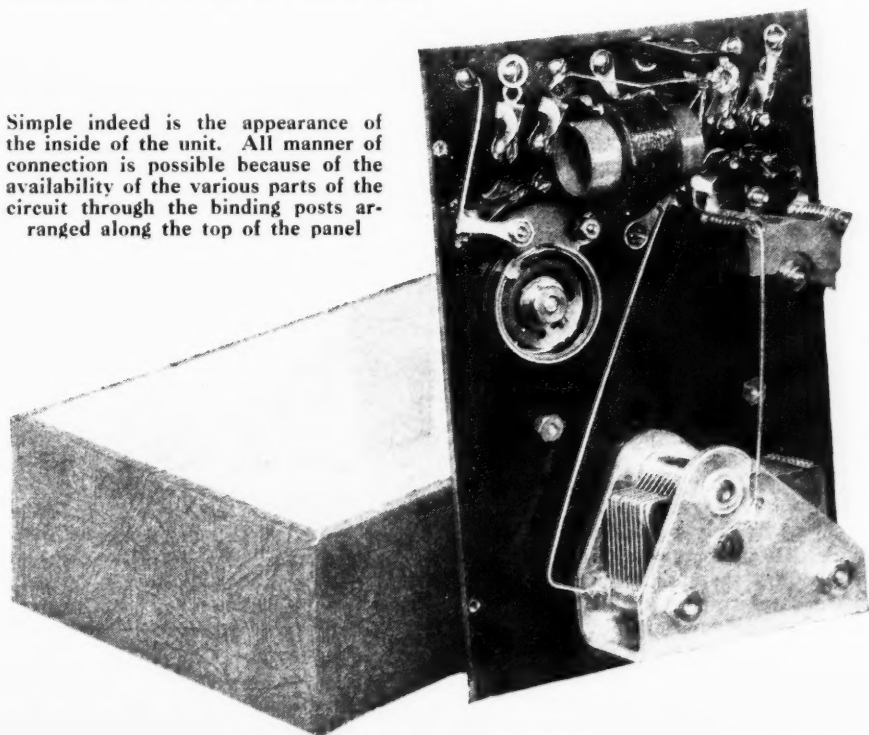
Balancing to prevent oscillation is accomplished by means of a midjet condenser. And the same instrument provides any degree of regeneration up to the "spilling" point. Thus the pre-amplifier can be kept "hot" at all frequencies.

Perhaps the owner of a broadcast set is troubled by broad tuning that permits locals to monopolize too much of his dial. With a multi-unit he has two remedies; either to use it as an additional radio-frequency stage, with a gain in selectivity, or to connect it as a wave trap in various ways. Tune the trap to the unwanted station, the set to the wanted one, and there you are.

Directions for using the unit cannot be given in detail here. But to illustrate the simplicity of connecting it in different ways, here are instructions for employing it as a short-wave adapter or converter with a direct current receiver.

"Connect red wire of adapter plug to binding post No. 7, black to No. 2, yellow to No. 6. Remove detector tube from receiver and insert in socket "T" of unit. Insert plug in detector socket of set. Remove antenna from set and connect to post No. 1. Fasten ground wire to post No. 2. All tuning is done with the dial of multi-unit.

Simple indeed is the appearance of the inside of the unit. All manner of connection is possible because of the availability of the various parts of the circuit through the binding posts arranged along the top of the panel





The Junior RADIO Guild



What Is an Audio-Frequency Amplifier?

Lesson III

IN Lesson No. 2 was described the action of detection or rectification performed by the detector tube and its associated circuits. It will be remembered from this previous lesson that the character of the incoming signal, composed of radio frequency alternations or oscillations, was changed, through the action of the detector tube so that a variation in the strength of the current in the plate circuit of that tube was produced. It was this varying current, which, passing through the windings of the small electromagnets in the ear-phones, produced the sounds which we recognized as speech or music.

As described, this varying current was not of an alternating character, but was of a direct, pulsating character. That is, the current flowed constantly in one direction, the sound being produced through the medium of the 'phones by virtue of the changing, varying strength of this current. It is important to remember this, because it has a direct bearing on the following description of the theory of operation of an audio-frequency amplifier.

Magnetism and Electro-Magnetic Induction

There are certain metals which possess the property of attracting to them scraps of iron or steel and are known as artificial magnets. A substance naturally possessing this property and found in the earth is known as lodestone, and if a bar of hard steel is rubbed with the lodestone the steel will become magnetized and is then an artificial magnet. Simple experiments will prove that the strongest force of attraction exists at the ends of the magnetized bar, and are known as the poles.

This stronger force which exists at the poles can be very well illustrated by placing a piece of paper over the bar magnet

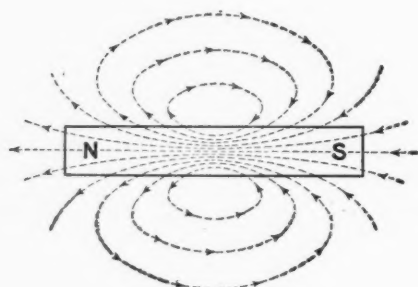


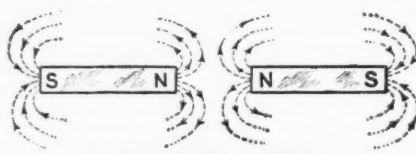
FIG. 10

In a steel bar which has been magnetized, the lines of force, if they could be seen, would shape themselves into the pattern shown above. The arrow-heads indicate the direction of flow of these lines of force

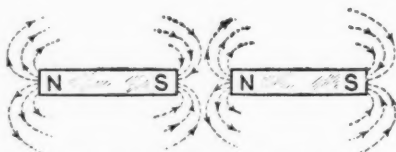
HEREWITH is presented the third Junior Radio Guild lesson. It explains in simple, understandable terms how an audio amplifier works and describes in detail the construction of a two-stage audio-frequency amplifier which is to be added to the single-tube tuner unit described in last month's lesson.

In this first series, consisting of five lessons, the various diagrams and sketches are consecutively numbered. Thus, the first figure in this, the third lesson, is Fig. 10.

To gain a comprehensive idea of the general construction of the five-tube receiver, part by part, it is well to compare the present lesson with its various sketches and photographs with those which have already been printed.



LIKE POLES REPEL



UNLIKE POLES ATTRACT

FIG. 11

If two magnetized bars are placed with similar ends together, as shown at the top, there will be a repelling action; if unlike poles are placed together they will attract each other (bottom)

and then sprinkling iron filings on the paper. The filings will be seen to assume a definite pattern on the paper, more filings accumulating at the ends than at the middle. This pattern shows the general direction of the magnetic force and indicates that the space about the poles of a magnet is in a state of stress or strain. The space occupied by these magnetic lines of force is termed the magnetic field, and the total lines of force found in this field are called the magnetic flux. See Fig. 10.

Bars of steel so magnetized and left to swing freely or pivoted will point to the north magnetic pole, like the needle of a compass. The end which does point to the north is known as the north pole of the magnet, while the opposite end is the south pole.

Experiment will prove that if two magnetized bars of steel are brought close together, with the north pole of one near the north pole of the other, there will be produced a distinct repulsion. This is also true if both south poles are brought together. On the other hand, if a north and a south pole are brought near each other, there will be noticed a distinct attraction. This phenomenon gives rise to the observation that like poles repel, while unlike poles attract. See Fig. 11.

Now if we wind a coil of wire and attach to the two coil terminals some indicating device, such as a galvanometer or other sensitive meter, and then thrust the bar magnet within the coil, a movement of the needle on the indicating device will be noted. This movement or deflection is only momentary, the needle coming to its former zero position when the bar magnet is held stationary within the coil. When, however, the bar is withdrawn from the coil, another similar deflection of the needle is noted. What has happened is that the magnetic lines of force, or the flux of the bar magnet, in cutting across the turns of the coil, induced in the coil a current which caused the meter to indicate it.

If over the bar magnet is wound a coil of wire, with its ends connected to a battery or other source of voltage supply, then the whole is known as an electro-magnet. Now, if this electro-magnet is thrust within the first coil, a greater deflection of the indicating meter will be reproduced than when only the plain bar magnet was used. See Fig. 12.

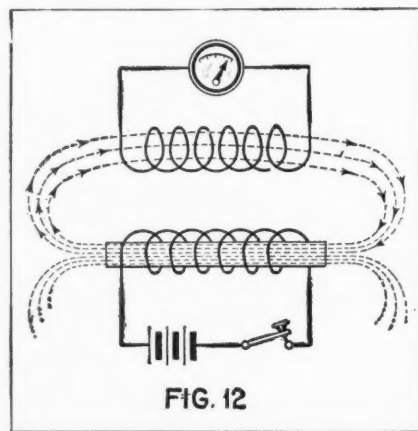


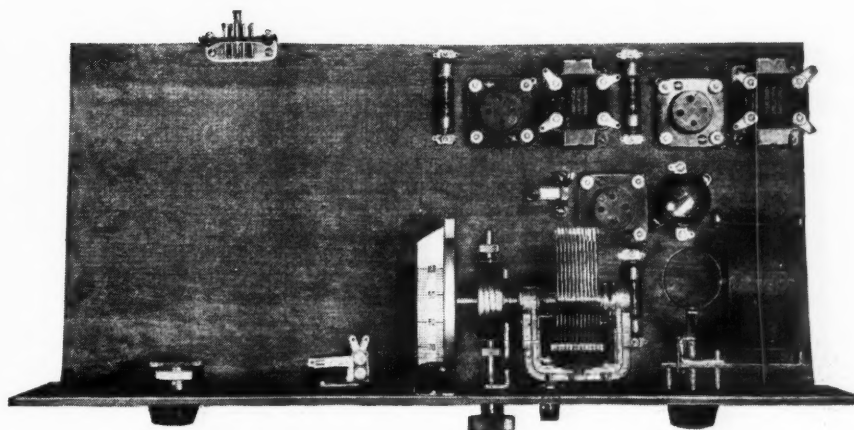
FIG. 12

When the circuit of an electromagnet is closed momentarily a current will be induced into another coil located in close proximity to it

However, as before, the deflection will be caused only when the electro-magnet is actually being moved through the first coil, but not when it is at rest. From this it will be observed that a current indication is obtained only when the electro-magnet is moving through the coil, thereby inducing in it a current. When the electro-magnetic field surrounding the electro-magnet is stationary, then no current is induced in the second coil, but when the electro-magnetic field is in motion the magnetic lines of force or flux of the electro-magnet are acting upon the second coil, thus inducing therein a current.

Now the flux of the electro-magnet can be made to move in several ways. Either the electro-magnet itself can be made to move or rotate so that the lines of force which are set up cut through or cross the turns in the indicating coil, or the connection to the battery supplying voltage to the winding about the electro-magnet can be periodically opened and closed, thus causing the flux or magnetic field to rise and collapse about the electro-magnet.

This entire action can be amplified or more closely observed if a core be added



Here is the JRG receiver with the two-stage audio channel added to the tuner, described last month

Below is given the complete schematic circuit diagram of the two-stage audio-frequency amplifier described in these pages

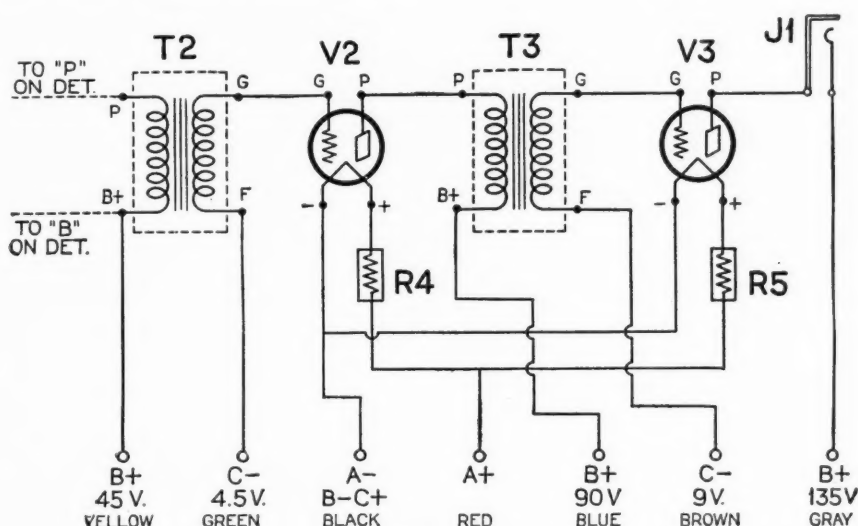


FIG.13

to the existing apparatus. The core would then take the place of the bar magnet, the first coil being wound on one of the legs of the core, with the second or indicating coil being wound on another. This entire collection of apparatus would then resemble a transformer, consisting of a primary coil (the one with the battery attached to its terminals), a secondary (the one with the indicating meter attached to its terminals) and a core.

As has been explained, if the connection in the battery or primary circuit be closed, then a momentary reading or deflection on the indicating meter will be noted only for that fraction of a second which is taken by the lines of force set up by the primary circuit to completely thread their way through the secondary coil. During the time the connection is closed there will be no deflection of the indicating needle because the flux or lines of force are stationary. However, when the connection is opened, a deflection similar to the first will be noted.

The Audio-Frequency Transformer

Now, if in place of the constant current flowing through the primary from the battery, a current varying in strength is applied to the primary circuit, then the electro-magnetic field set up by the primary will vary in accordance with the variations in the strength of the current flowing through the primary, thus causing a varying movement of the flux which is threading its way through the secondary.

Previously it was observed that when the connection to the battery circuit was closed, a deflection in one direction on the meter was noted, while when the connection was opened, the deflection was in the opposite direction. This was caused by the rising of the flux when the connection was closed, causing a deflection in one direction while when the connection was opened, thus allowing the flux or magnetic field to collapse, the current in-

duced in the secondary was in the opposite direction, thus causing an opposite deflection. This rise and fall of current is quite important to remember, because it is necessary to keep it in mind when observing what is taking place when, instead of the make and break of the current by opening and closing the battery connection, a varying direct current is applied to the primary. What happens in this instance is that the varying flux set up by the primary circuit induces in the secondary circuit an alternating current of greater voltage than that originally found in the primary circuit. This step-up is caused by the fact that the secondary coil has many more turns than the primary; in fact, this step-up is a function of the ratio of proportion which exists between the primary and secondary. If the latter has five times as many turns as the former the ratio is said to be 5 to 1.

Observe now that after applying an alternating radio frequency signal to the grid of the detector tube and then rectifying or detecting it so that we could employ the audio frequency variations to actuate a pair of phones, we are now applying this pulsating direct current audio frequency signal to the primary of an audio transformer and obtaining at its secondary terminals an alternating current signal, enlarged by virtue of the amplifying characteristics of the step-up transformer. This alternating current signal cannot be compared to that originally absorbed by the antenna because the antenna signal was of a radio frequency or inaudible nature, while this which we now have is of an audio frequency or audible nature.

As a simple comparison, the action of the transformer in performing the task assigned to it can very well be likened to the cutting of a loaf of bread. You can have your bread, and even go so far as to place the knife upon it, but, unless you give motion to the knife, moving it backward and forward, there will be no cutting of the bread. It is the same with a transformer. You can have the two windings, the core, and the current in the primary circuit, but, unless this current is varying in nature to cause a setting up and collapsing of the magnetic field, there will be no current induced in the secondary circuit. When the current in the primary remains constant, then a stationary flux or magnetic field is set up, but no current is induced in the secondary.

(Continued on page 354)

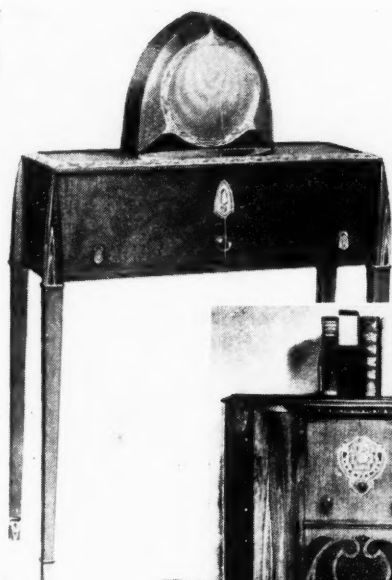
1930 Styles and Specifications for Receivers and Speakers

ON the following pages are grouped representative illustrations of new model receivers, chassis, cabinets and speakers; showing the variety and trends in design provided by manufacturers.

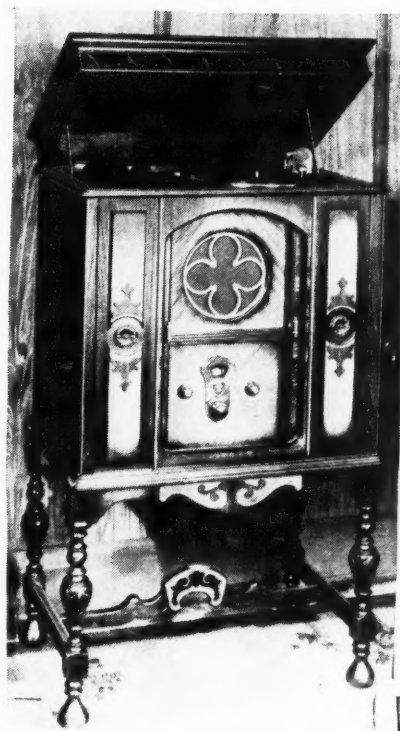
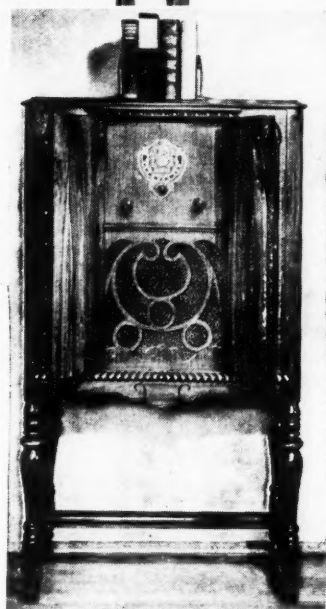


IN tabular form, also, are given the essential facts as to number and types of tubes for as many receivers as this information was available, at the time of going to press; as well as the characteristics of leading makes of loud speakers.

1930 Styles and Specifications for Receivers and Speakers



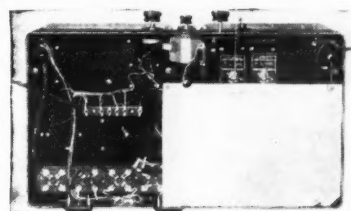
Above, Graybar Electric Company; at the right, Columbia Phonograph Company; below, Travler Manufacturing Company



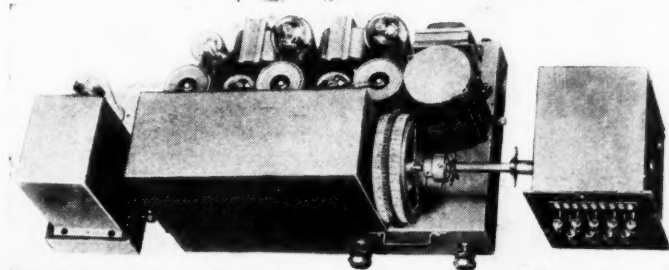
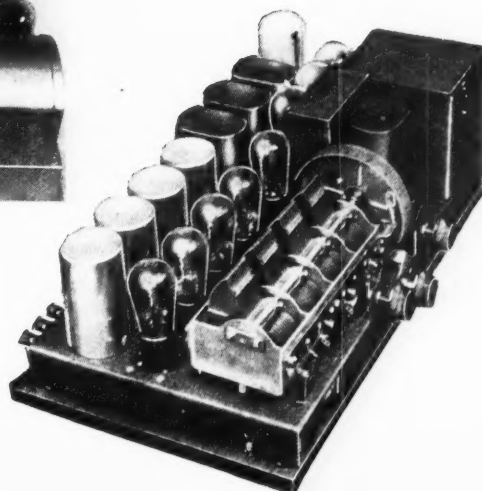
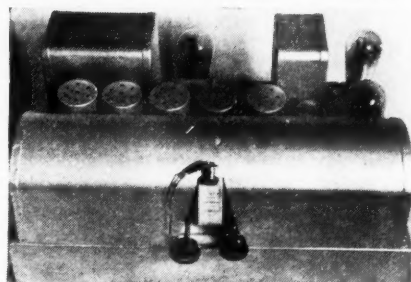
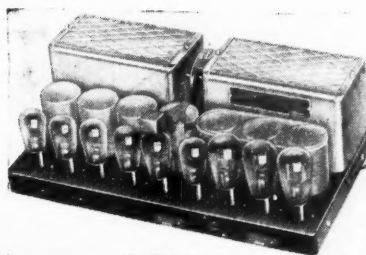
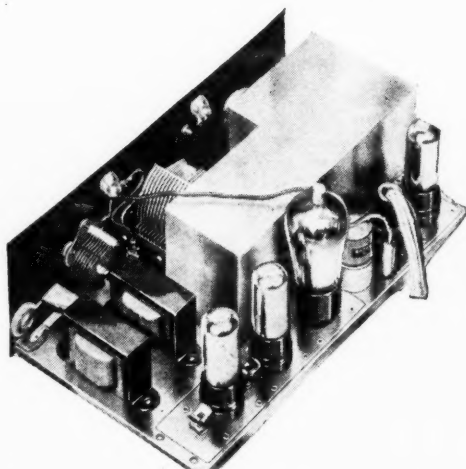
Above, Pierson Cabinet



Above, Stromberg-Carlson Tel. Mfg. Co. console; below, Lafayette Duo-Symphonic

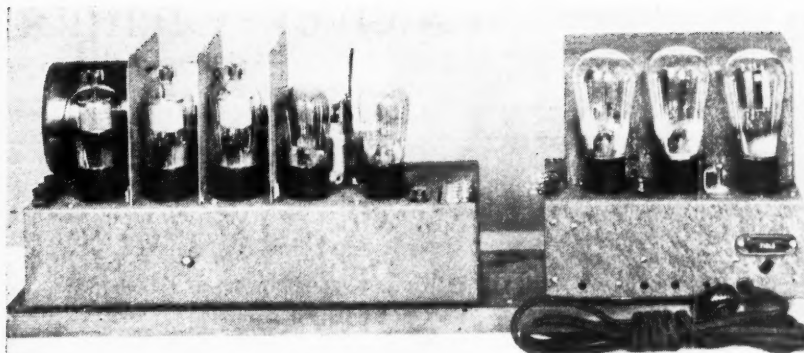


Center of page, top view of Lafayette Duo-Symphonic; immediately below, Balkeit chassis, Model C (Fansteel Products, Inc.); lower left corner, Zenith chassis with push-button tuning; directly below, Bremer-Tully chassis



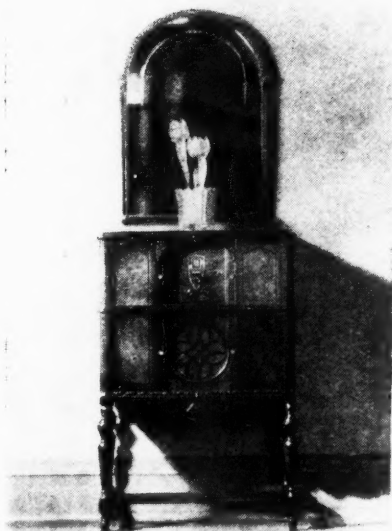
Receiver Characteristics

Manufacturer	Model Number	NUMBER AND TYPE OF TUBES											
		R. F.	DET.	1st A. F.	2nd A. F.								
A-C Dayton A-C Dayton Co.	98 9960 9970 9990 9100 9980	Five '27	'27	Two '45									
Acme Acme Elec. & Mfg. Co.	88 77 Console A-C-7				Three '27 " " " " " " " "	'27 " " " " " " " "	Two '45 '45 Two '45 '71A						
Amrad American Radio and Research Corp.					Three '24	'27	'27	Two '45					
Apex U. S. Radio & Television Corp.	No. 36 No. 50 No. 55 No. 89 No. 60 No. 70 Console				Three '26 " " " " " " " "	'27 " " " " " " " "	'26 " " " " " " " "	'71 " " " " " " " "	Two '71A Two '45				
Atwater Kent Atwater Kent Mfg. Co.	55 Screen Grid, Table No. 55 Chassis Console				Two Screen Grid	'27	'27	Two '45 Push-Pull					
Balkeitt Faustel Products, Inc.	Console Chassis				Four '27 Three '27	'27 " "	'27 " "	Two '45					
Bosch American Bosch Magneto Corp.	48 Table Console De Luxe	Three '24	'27	Two '45									
Brandes The Brandes Corporation	B-10 B-11 B-12	Three '27 " " "	'27 " " "	'27 " " "	'71A Two '45								
Bremer Tully Chicago	81 82 80	Three '27 " " "	'27 " " "	'27 " " "	Two '45 Two '71								
Brunswick	No. 14 No. 21 No. 31	Three '27	'27	'27	Two '45								
Buckingham Buckingham Radio Corp.	No. 6950 No. 2 No. 1 No. 3 Phono-Radio Phonograph	Four '26 None	'27 None	'26 None	Two '71A None								
Bush and Lane Bush & Lane Piano Co.	No. 20 No. 21 No. 30 No. 32 No. 34 No. 40 No. 60 No. 50 No. 70 No. 90 Phono Radio	Three '27	'27	'27	Two '45								
Colonial Colonial Radio Corp.		Three '27	'24	'27	Two '45								
Continental "Star Raider"	R-20 R-30 R-P-40	Six Cardon Heaters	Cardon Heater	Two '50									
Crosley Crosley Radio Corp.	32 22 42 82 31 21 41	Four '26 Five '27 Four '26 Three '22 Four '26	'27 " " " " " " " "	Two '71 Two '45 '71A '71 '71A									
Day Fan	68 72 69 66 73 Console	Four '26 Four '01A	'27 '01A	'26 '01A	Two '45 "12"								
Earl Chas. Freshman Co., Inc.	No. 22 No. 32 No. 31 No. 41	Four '26 Four '27 " " " "	'27 " " " "	Two '71A Two '45 " "									
Edison Thos. A. Edison, Inc.	"R-4" "R-5" "C-4"	Three '27	'27	'27	Two '45								
Erla Electrical Research Laboratories	R2 Screen Grid	Three '26 Two '24	'27 " "	'26 " "	Two '71A Two '45								
Emerson Emerson Radio & Phono. Corp.	"C" Console "D" Console	Three '26	'27	'26	Two '45								
Eveready National Carbon Co., Inc.	No. 31 No. 32 No. 33 No. 34	Three '27	'27	'27	Two '71 Push-Pull								
New "40" Series with Two '45 Push-Pull	42 43 44					Three '27	'27	'27	Two '45 Push-Pull				
New "50" Series Screen Grid										Three '24	'27	'27	Two '45 Push-Pull
Federal Federal Radio Corporation	L-36 L-46 M-41 M-46									Three '24 " " " " Three '27 " " " "	'27 " " " " " " " " " " " "	Two '45 " " " " " " " " " " " "	
Fada F. A. D. Andrea, Inc.	20 25 35 75 77	Three '27 Two '24 " " " " Three '24 " " " "	'27 " " " " " " " " " " " " " " " "	'27 " " " " " " " " " " " " " " " "	Two '71A Two '45 " " " " Two '10								
"Freed" Freed-Eisemann	55 78 79 95	Four '26	'26	"	Two '71								
Gilfillan Bros., Inc.	100	Four '27	'24	'27	Two '45								
Graybar Graybar Electric Co.	311 310 320 340 340	Three '26	'27	'27	'71								
Grebe Synco-phase A. H. Grebe & Co., Inc.	270 285 450	Three '24	'27	Two '45	Push-Pull								
Gulbransen Gulbransen Piano Co.	291 292 295	Four '26	'24	'26	Two '45								
High Frequency Laboratories Chicago	Chassis	Feeds either a.c. or d.c. dynamic. One dial, one spot tuning, 10 tubes, Superheterodyne Four screen grid tubes, 4 '27 tubes, 2 '45 tubes Uses five tuned filters, each individually adjustable.											
Howard Radio Co. Chicago		Four '26	'27	Two '45									
Kennedy Colin B. Kennedy, Inc.	310 210	Three '27	'27	'27	Two '45								
Kolster Kolster Radio Corp.	45 44 43	Three '24 " " " " " " " "	'27 " " " " " " " "	'27 " " " " " " " "	Two '27 Two '50 in 3rd Stage Two '45								
Seven Seas C. R. Leutz Inc.	Seven Seas	Three Screen Grid	'27	'27	Two '10								
Kellogg Kellogg Switchboard & Supply Co.	523 524 Phono Radio	Three '24 " " " " " " " "	'27 " " " " " " " "	'27 " " " " " " " "	Two '45 Two '50								
"National"	Chassis	Four '27	'27	'27	Two '45								
Lyric Alt-American Mohawk Corp.	93 SG1 95	Five '27 Three '24 Five '27	'27 " " " " " " " "	Two '27 Push-Pull " " " "	Two '45 Push-Pull								
Majestic Grigshy Grunow Co.	Console	Four '27	'27	Two '45									
McMillan Radio Corp.	Console	Four '26	'27	'26	Two '45								
Minerva Radio Co.	Console	Three '27	'27	'27	Two '45								
Norden Hauck, Inc. Philadelphia		Five '24	'27	'27	Two '45								
Philco Philadelphia Storage Battery Co.	65 Low Boy Hi Boy De Luxe Hi Boy Lo Boy 87 Hi Boy 87 De Luxe Hi Boy 87	Two Screen Grid	'27	Two '45 Push-Pull									

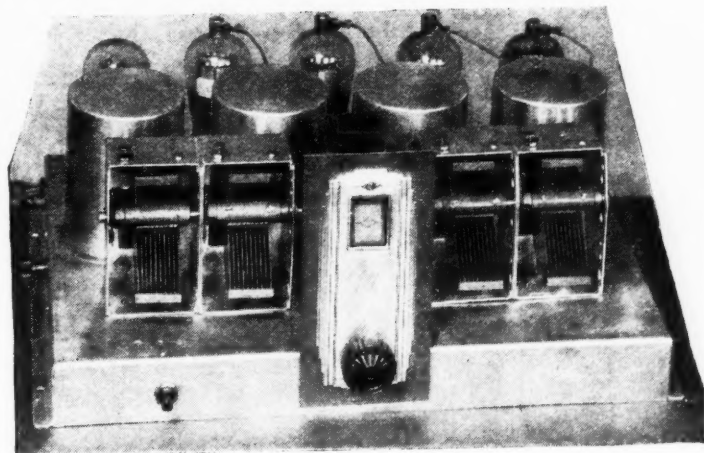


Above, Eveready chassis (National Carbon Company); at the left, the Lyric Radio (All-American-Mohawk Corporation)

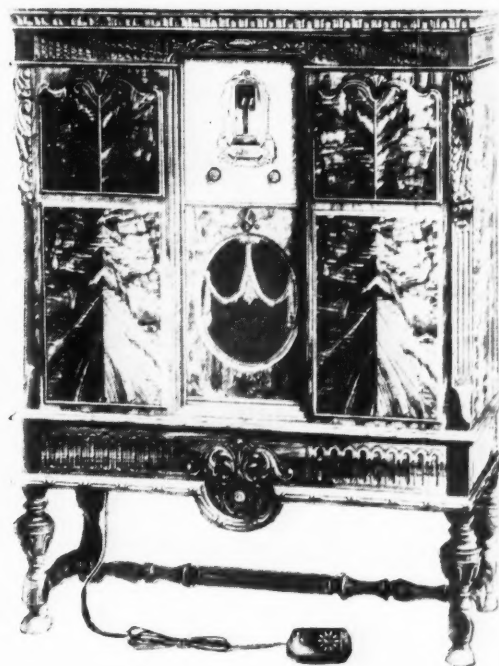
Below, the new Majestic Radio (Grigsby-Grunow Company)



Above, Roemer Radio (Rudolf Roemer Furniture Company); at the left, a Bosch console radio (American Bosch Magneto Corporation)



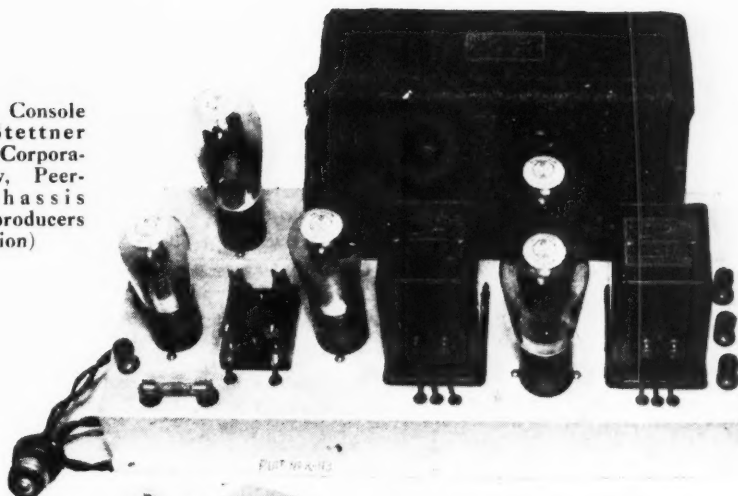
The MB-29 (The National Company)



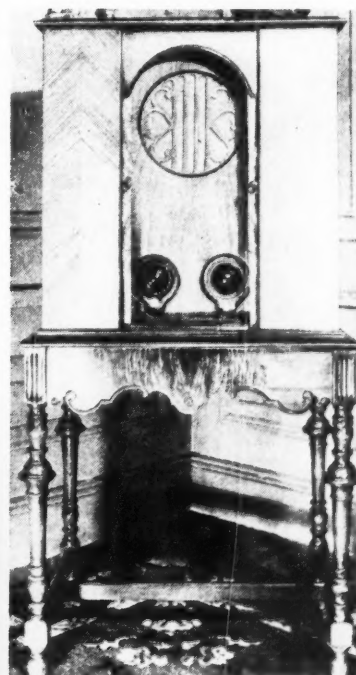
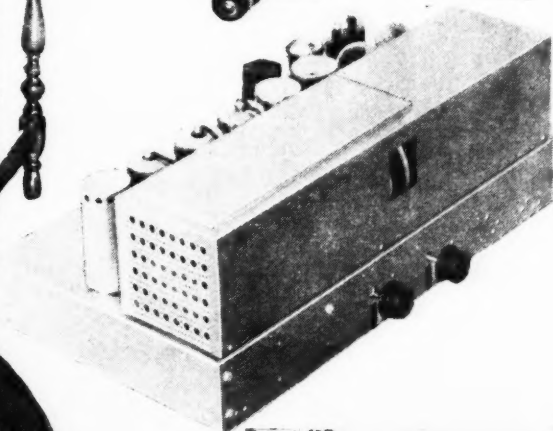
New Zenith model with remote-control tuning



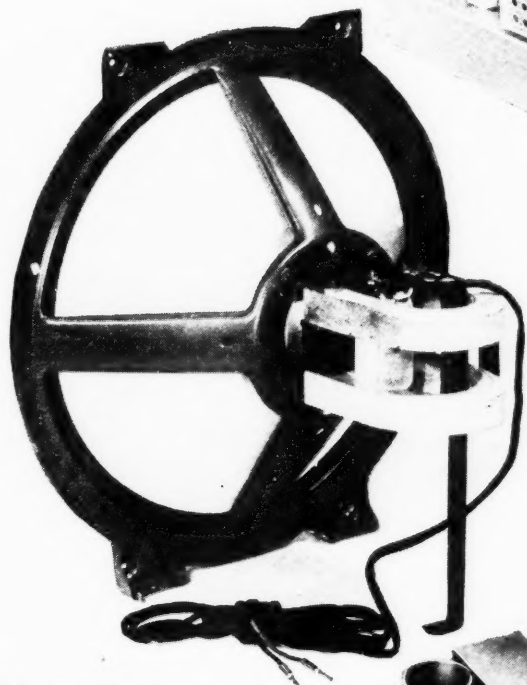
At the left, Console cabinet (Stettner Phonograph Corporation); below, Peerless radio chassis (United Reproducers Corporation)



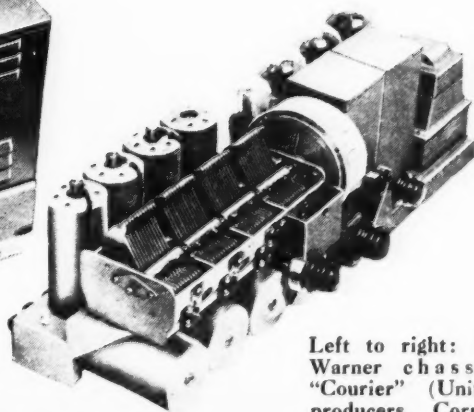
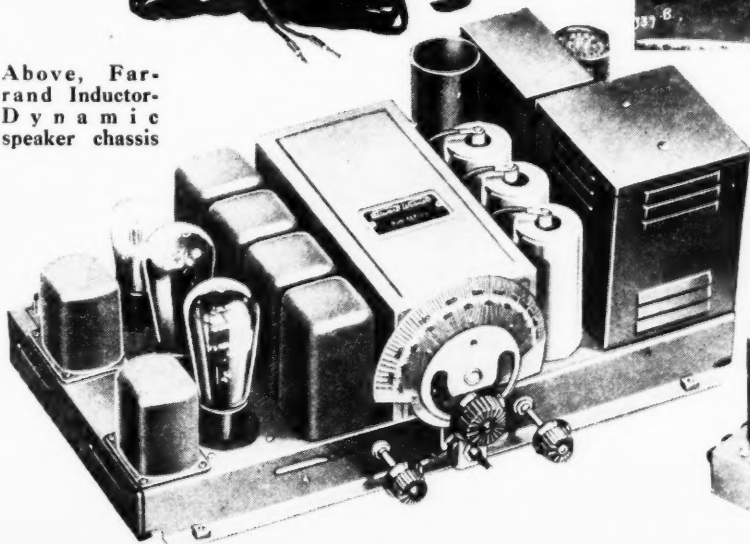
Above, Pilot power amplifier No. K113



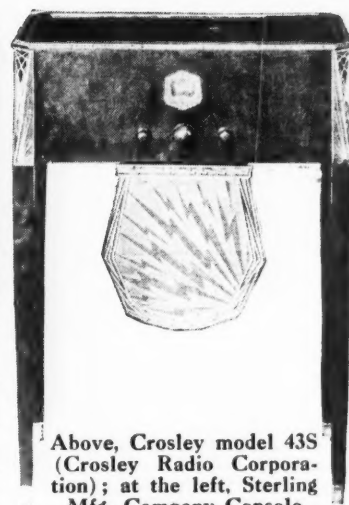
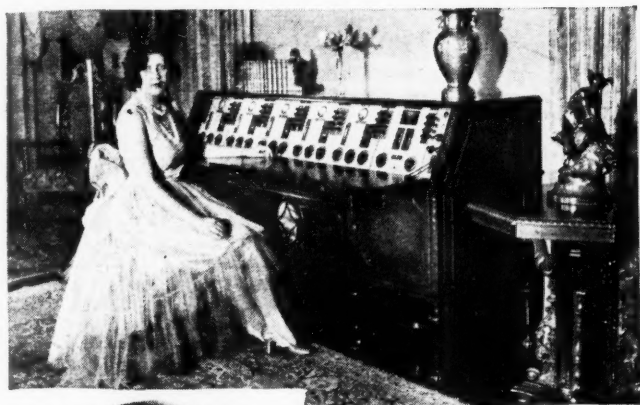
Above, Superior Cabinet Corp. console for Atwater Kent; at the left, the new Ware radio console (Ware Manufacturing Company)



Above, Far-
rand Inductor-
Dynamic
speaker chassis

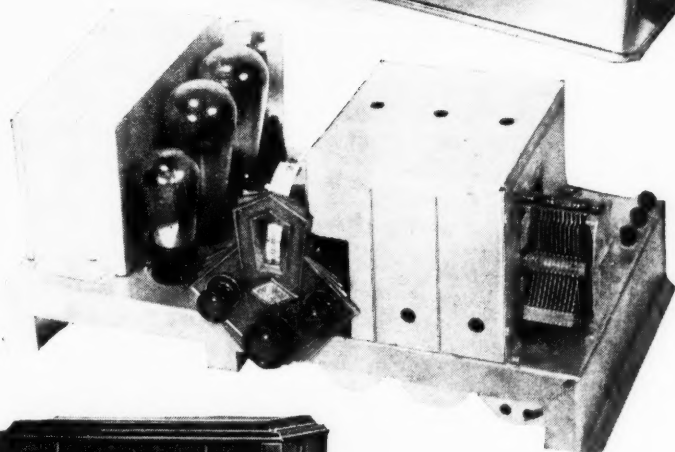
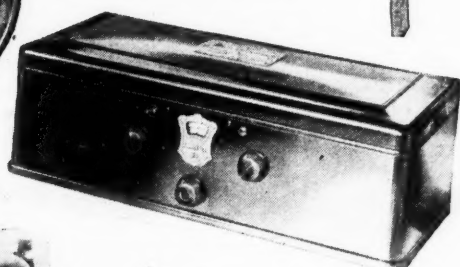
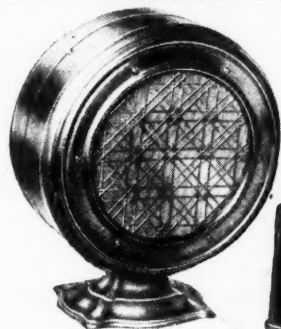


Left to right: Stewart-Warner chassis, and "Courier" (United Reproducers Corporation)



Above, Silver Ghost receiver (C. R. Leutz, Inc); below, Atwater Kent table model set and speaker

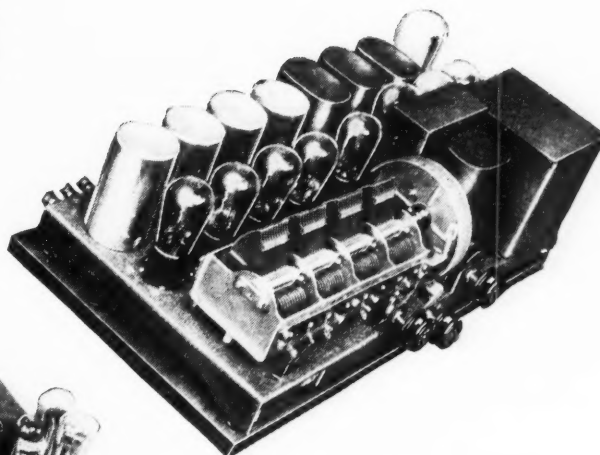
Above, Crosley model 43S (Crosley Radio Corporation); at the left, Sterling Mfg. Company Console



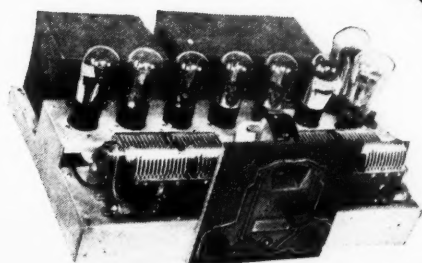
Above, Silver - Marshall chassis No. 722; at the right, above, Fada Highboy (F.A.D. Andrea, Inc.); below, chassis of the Metrodyne receiver



Above, R. C. A. superheterodyne (Radio-Victor Corporation)



Above, chassis of Brunswick Radio (Brunswick-Balke, Collender Co.)



The Radio Forum

*A Meeting Place for Experimenter, Serviceman
and Short-Wave Enthusiast*

The Experimenter

Students of radio receiver circuits often ask how it is possible to provide different grid bias voltages on various tubes when the grid returns are all connected to the same point, namely, the negative terminal of the B battery eliminator. That this question, says Mr. J. E. Anderson, of New York City, should be confusing is no wonder, for often the circuits are drawn in such a complex and intricate manner that even one well versed in the subject often must analyze the circuit before he is sure of the various voltages applied.

But a circuit may be drawn so that it is just as easy to tell the various voltages as it is to tell which is up and which is down. It is then only necessary to remember that the positive terminal on the plate voltage supply is up with respect to any other point in the circuit, and that the negative terminal is down with respect to any chosen point. It should also be remembered that the filament or the cathode of any tube is the point from which the plate and grid voltages are measured with respect to that tube.

Simplified Circuit

Fig. 1 shows a typical transformer coupled audio amplifier with grid bias detector. The filaments of this circuit are heated with a. c. because it is in this type of circuit where the voltages are most confusing. A separate grid bias resistor is used for each tube in order to more clearly show the voltages.

R4 and R5 are two resistor sections in

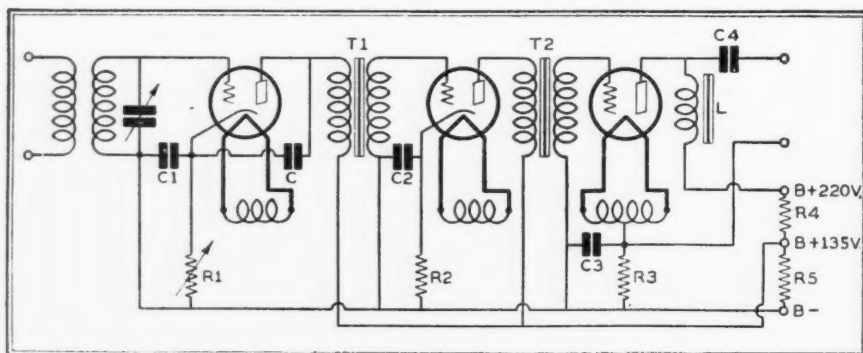


Fig. 1

the B battery eliminator voltage divider. Only three of the binding posts on the eliminator are shown. The plate returns of the first two tubes go to the 135 volt point on the voltage divider, the voltage being measured from B minus. The plate return of the power tube is connected

to the highest point on the eliminator, which is 220 volts above B minus.

The plate current flows from the taps on the voltage divider toward the plate. Since the primaries of the transformers T1 and T2 have some resistance, the voltage at the plates is less than at the



When laying out a panel, base, etc., be sure to make accurate markings by means of a scribe and square

B plus end of the transformers. The current flows from the plates to the cathodes. Since there is a high resistance between the plate and cathode, there is a considerable voltage drop between these elements. This drop is the effective plate voltage on the tubes.

But the current continues to flow down through the grid bias resistors. There is an additional drop in them and this drop is the grid bias. The drop in the resistance R5 is equal to the drops in the primaries, the plate to cathode resistance and the grid bias resistors.

Voltages in Power Tube

The same thing happens in the power tube. There is a total voltage drop of 220 volts available, which is the drop in R4 and R5. This drop is equal to the

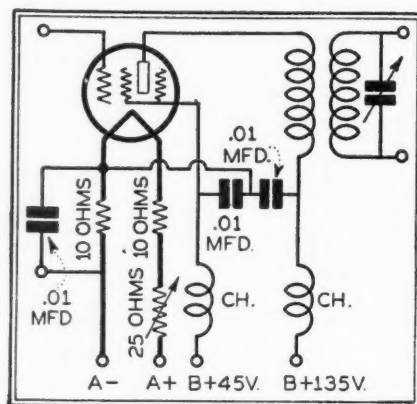
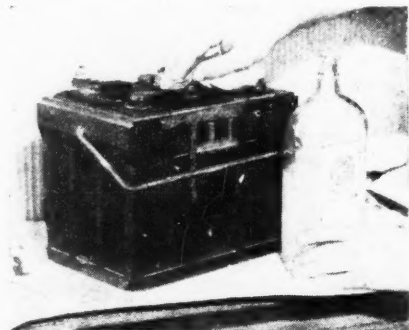


Fig. 2

drops in the choke coil L, the plate to filament resistance and the grid bias resistor R3.

In order to get the proper voltages on the tubes, it is only necessary to proportion the grid bias resistors and the plate resistances properly. The detector tube



Keeping the cell covers and terminal posts of a storage battery clean by means of an ammonia wash lengthens the battery's useful life

requires a high negative bias for best results. Hence R1 is made large, and it is also made variable because the required bias is critical. The other two bias resistors, R2 and R3, may be fixed. The values depend more on the tubes used than on the total voltages applied.

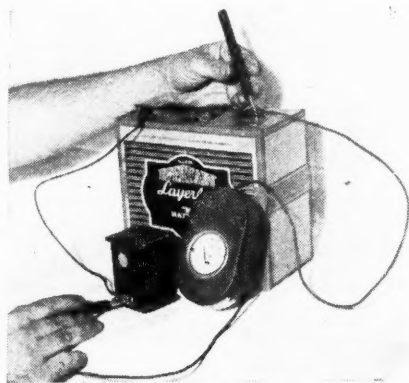
It will be observed that all the grid returns are connected to the same point, namely, B minus. Yet there is a different grid bias on each tube because there is a different voltage drop in each of the resistors, R1, R2 and R3.

Another problem that arises frequently is the connection of by-pass condensers. When possible all by-pass condensers should be connected from the

(Continued on page 360)

The Serviceman

"Many times," says Mr. D. A. Brown, of Marion, Ohio, "the serviceman and the set builder run across small fixed condensers on which there is no capacity marking and also when he would like to know the capacity of various components of a set. A simple device for determining this can be constructed at a maximum



When making continuity tests, a voltmeter and "B" battery are important items

cost of \$9. The device employs the capacity bridge principle, similar to that used in the laboratory test equipment. Our capacity bridge uses either the common a. c. or an audio oscillator for a resonance indicator.

The connections are shown in Fig. 1. In order to place the bridge in operation it is first necessary to balance it perfectly. This is done by inserting a fixed condenser of .001 mfd. as C1. This condenser should be of a high grade mica insulation type. By listening in on the phones

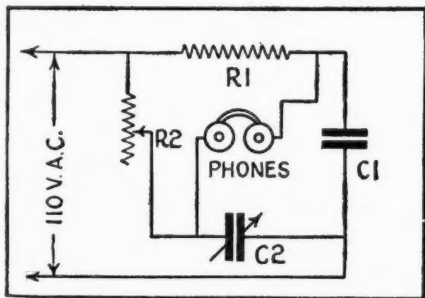


Fig. 1

and varying the resistance R2 and the condenser C2 the a. c. hum can be entirely eliminated. The bridge is now balanced and the resistance R2 should be left in this position permanently. All future adjustments are made with C2. When the hum disappears (resonance point) C2 will be practically at maximum. Now our capacity bridge is ready for testing unknown capacities. Remove the condenser C1 which we use only for preliminary adjustments, and in its place insert the condenser to be tested. Then vary dial on C2 until the a. c. hum disappears. At this point the dial setting of the condenser C2 indicates the capacity of the condenser under the test. C2 being of a straight line capacity type and

equipped with 0 to 100° dial, the capacity of the condenser under test may be read directly from the dial set. In other words, if the a. c. hum disappears at 50° on the C2 dial, then the condenser on test is half of the standard or .0005 mfd. A dial reading of 25 would be .00025 mfd, or the condenser on test and the dial reading would be $\frac{1}{4}$ of the maximum capacity of the standard. A parallel or series group on condensers may be tested in this circuit providing of course the unknown capacity is not below the minimum or above the maximum of the standard C2. A 25 watt lamp is inserted in the 110 volt a. c. line, to limit the current in case one of the condensers on test

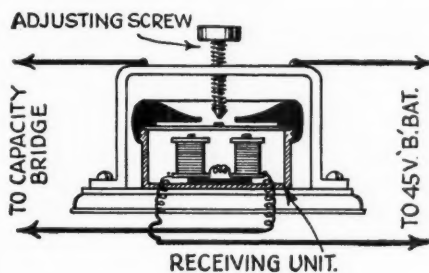


Fig. 2

breaks down. If the condenser is shorter the lamp will glow very red and if condenser is open it will be impossible to balance the circuit. For the average experimenter the 110 volt a. c. line will serve as a good resonance indicator, but better and sharper results may be had if the 110 volts a. c. line is replaced with an audio oscillator or microphone hummer. A microphone hummer is shown in Fig. 2. This hummer is made up from an old receiver or loud speaker unit.

Mr. Brown has also devised a method of obtaining a field supply for the dynamic speaker testing. This tester, as

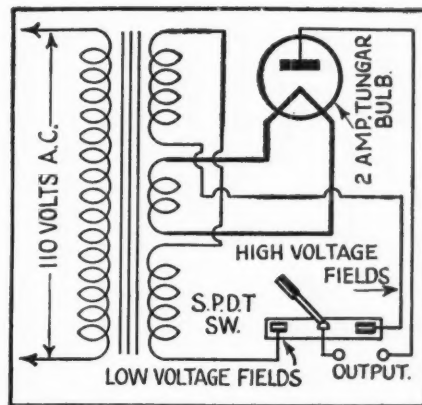


Fig. 3

shown in Fig. 3, saves considerable time when a speaker is brought in for repairs and the field supply system has been left on the job. As the bringing into the repair station the filed supply system, would mean dismantling quite a portion of the set equipment. A battery charger of the tungar type is used as a current supply for making tests. The output of this type of charger is usually around 6 volts for "A" battery charging. This will furnish the field current for the low voltage excitation of the field coil. The high voltage tap on the charger used to charge "B" batteries supplies around 100 volts which will also furnish the field current for the high voltage type of dynamic speaker. A small single pole double throw switch, shown in Fig. 3, allows a ready method of changing the voltages. A charger so equipped has been used in service work by myself with considerable satisfaction and for the repair man who likes current supply in compact unit this furnishes a reliable source which, when not used for this type of work, can be used for its specific purpose of charging batteries.



Checking the "B" voltage of a receiver is something that should be carefully observed. A momentary contact of the meter to the battery is advisable if run-down batteries are to be avoided

On Short Waves

Regeneration

Before discussing regenerative action as applied to short-wave receivers, let us open up the radio dictionary, stopping at that word. "Regeneration is the action by which a part of the energy from the plate circuit of a tube is fed back into the grid circuit of the same tube. The plate circuit energy is added to the energy already in the grid circuit.

The outline of any subject is easier understood when circuit drawings are used. So let us begin by referring to Fig. 1, where is shown a three element vacuum tube, with its associated inductance and the capacity in the grid circuit

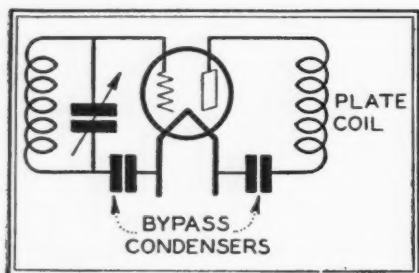


Fig. 1

and inductance in the plate circuit. The grid portion of this circuit is known as the input circuit of the tube, and the plate portion as the output circuit. The impressed signal on the grid circuit and the voltage changes in the signal cause corresponding voltage changes on the grid of the tube. These varying voltage changes on the grid of the tube, control the flow of a greatly magnified current in the plate circuit. Therefore, the strength of the output energy in the plate circuit is directly proportional to the impressed voltage on the grid of the tube. It necessarily follows that if the signal strength is increased at the input of the circuit, greater current flow will result in the output circuit. Of course, many methods are available to increase the strength of the input signal. For example, a stronger signal is impressed on the input circuit when operated near a stronger

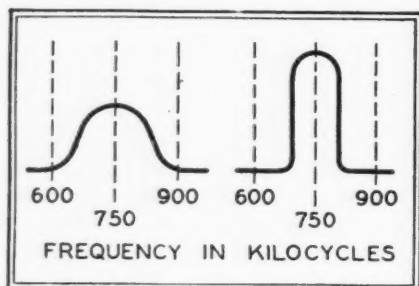


Fig. 2

broadcaster than from a distant, weak transmitter. However, we cannot all change our location to be near or in the neighborhood of a powerful transmitter. Regeneration then comes to our aid, whereby the regenerative action is employed to obtain a material increase in the input voltage applied to the input circuit.

When the grid circuit of a detector tube is tuned to resonance with the frequency of the incoming signal, the inductive reactance and the capacitive reaction in this circuit neutralize each other, leaving only the resistance of the associated

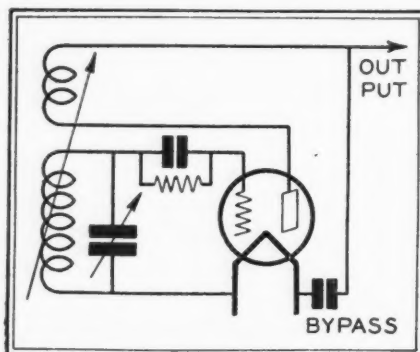
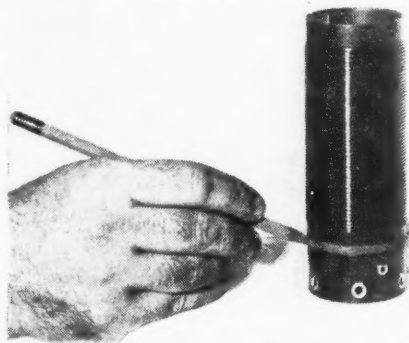


Fig. 3

apparatus to oppose the flow of current. If it were possible to reduce this resistance to zero, nothing would remain to oppose the current flow, so that once oscillating voltages are introduced in the circuit, they would continue indefinitely.



Fixed coupling between secondary and tickler coils makes it possible to calibrate detector tuning circuits with a fair degree of permanency and accuracy

Fact follows theory then that similar results may be obtained if just enough energy is added to that already in the grid circuit, so that the "added energy" supplied is sufficient to overcome the resistance losses. The added energy for the grid circuit may be obtained from the plate circuit as the maximum energy in the plate circuit is at the same frequency as that of the grid circuit. Resistance losses can therefore be overcome by feeding back the plate energy to the grid circuit. Sustained oscillations, independent of the incoming signal, will result with slight additional plate feedback, after resistance losses have been overcome. Just so long as the grid circuit absorbs energy from the incoming signal, is the tube in regeneration, with feedback in use. However, when the feedback is increased beyond this point, oscillation occurs, and will be sustained as long as the filament and plate supply last.

It will be seen that with the proper amount of regeneration that a weak signal can be built up materially. Thus, regener-

ation increases the sensitivity of the circuit as well as the selectivity.

In Fig. 2 the curve at the left graphically shows the side band of a receiver tuned at 750 kc. where the losses have not been overcome, while the curve at the right is "with regeneration." Since regeneration occurs at only the frequency to which the grid and plate circuits are tuned, it will be found that the frequencies 600 and 900 kc. remain at the same signal level as in the curve at the left. Fig. 2. A peculiarity with regeneration is that feedback occurs more easily at high frequencies. It is therefore necessary to control the feedback energy. This may be accomplished by a number of different methods, all providing smooth operation or as the short-wave fan expresses it, "sneaking up."

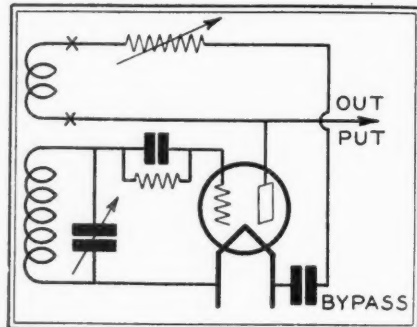


Fig. 4

Most generally used is the rotating tickler method shown in Fig. 3. The tuned secondary winding is wound on a stationary form and the tickler on a form slightly smaller in diameter than the secondary. This tickler rotates within the secondary winding. An extension shaft, complete with knob, controls the relationship between the secondary and tickler windings. As the tickler is rotated to increase its coupling to the secondary winding, the effective inductance of the tuned secondary coil is increased. It necessarily follows, therefore, that the tuning point

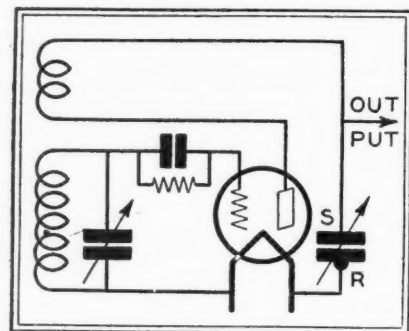


Fig. 5

at which the circuit resonates to a specified frequency will change with changes of the tickler adjustment. These changes produce a rather serious disadvantage in that the tuning circuit cannot be logged unless, of course, the dial reading for the tickler is noted as well as that of the secondary tuning circuit. When the voltages of the secondary and tickler coils are

(Continued on page 373)

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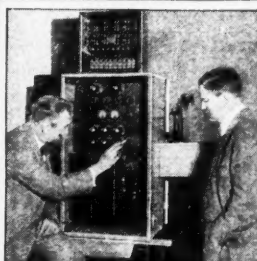
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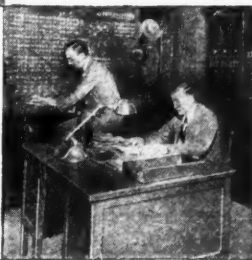


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The Junior Radio Guild

(Continued from page 341) •

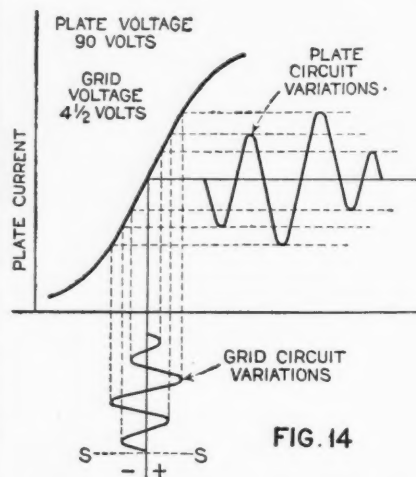
Like the knife, the magnetic field must be made to move before it can accomplish its work.

Audio Frequency Transformers and What They Consist Of

There are many styles and types of audio frequency transformers available today, but essentially they are alike in that they consist of a primary winding, a secondary winding, and a metallic core.

The most common type employs a core consisting of many layers of sheet metal, usually silicon steel, which are termed laminations. These laminations have three legs jutting out from a common side much like the letter "E."

The primary winding consists of many thousands of turns of fine wire wound on a spool or insulated tube, large enough in inside diameter so that it may readily be slipped over the center leg of the laminated core.



Due to the amplifying action of the tube a weak signal impressed on the grid is enlarged or magnified in the plate circuit

The secondary coil is wound directly over the primary coil, being separated from the latter by several layers of insulating cloth. This secondary consists of many more turns than the primary, and is usually wound with a finer wire. The number of turns by which the secondary is increased over the primary depends upon the ratio desired between the windings. If a transformer is rated at 3 to 1 or 5 to 1, then the secondary will have three times as many turns as the primary in the first instance and five times as many in the latter instance.

The coil assembly consisting of the primary and the secondary windings has its center hole filled with a pile of laminations, half with the legs of the "E" facing in one direction and the other half facing in the other. The laminations are inserted one by one, the direction of the legs being faced alternately in one direction and then the other. When the core

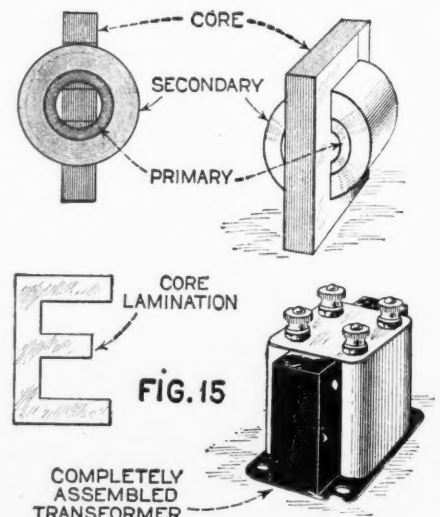
center has been filled, the laminations are clamped at the ends by straps of metal to prevent their working loose. Then the entire unit is enclosed in a metal can which acts as a shield so as to prevent the magnetic field of one transformer from intercoupling with an adjacent one. Suitable terminals are mounted on the shell can and insulated therefrom.

For details concerning the assembly of a transformer, see Fig. 15.

How the Audio Frequency Amplifier Tube Works

A glance at the amplifier circuit, Fig. 13, will show that the terminals of the secondary coil of the first audio frequency transformer are connected to the grid and filament of the succeeding tube. The filament connection is made through the C battery lead which terminates at that particular value of C voltage which is required for the type of tube employed. Normally, first stage amplifier tubes require from 3 to 4 1/2 volts of C battery to make them function satisfactorily. This C bias, as it is called, adjusts the tube to its correct operating characteristics and insures that, provided the proper amount of filament and plate voltage are employed, the tube will function successfully.

In Fig. 14 is shown the grid voltage-plate current characteristic curve of a first stage amplifier tube and indicates how the applied signal is amplified or enlarged through the amplifying action of the tube. It will be observed that unlike the characteristic curve for the detector tube, shown in Lesson No. 2, the signal is applied to the straight portion of the curve instead of the bended portion as in the case of the detector. Following the action through the tube,



An audio-frequency transformer in principle is much like the electro-magnet illustrated in Fig. 12. Two coils, a metallic core and a shell comprise the entire unit

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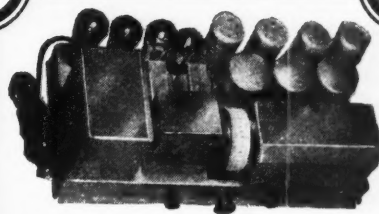
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it will be seen that the applied signal, indicated by the line S . . . S at the bottom of the figure causes a great variation in the plate current and in general enlarges the entire pattern of the applied signal, the while not changing its character.

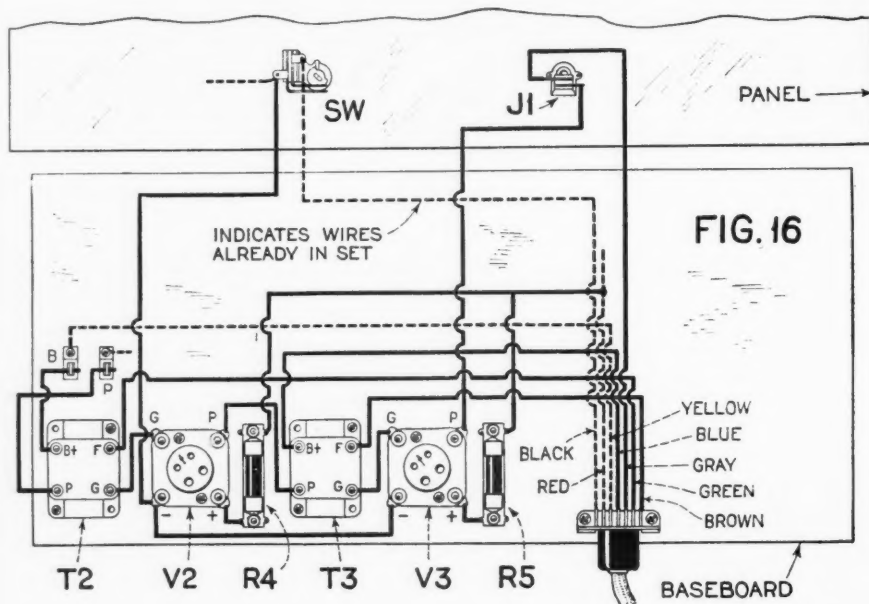
As in the case of the detector tube, the electrons emitted by the hot filament are attracted to the plate which is of positive polarity. When a positive alternation of the applied signal reaches the grid, the attraction of the electrons toward the plate are aided. If the positive alternation be great, then a great amount of plate current will flow. If the positive alternation be not so great, then a lesser amount of plate current will flow. When a negative alternation reaches the grid of the tube it retards the flow of electrons to the plate, thus causing a falling

reader obtain these parts and then proceed as follows:

First, study the photographic illustration on page 341 and the parts wiring diagram, Fig. 16, on separate sheet. Note the position of the transformers, the sockets and the amperites. Then temporarily place these parts on the baseboard of your receiver, getting them in approximately the same position as that shown in the photograph. To do this you may have to remove the two Fahnestock clips, which were previously used to take the phone tips.

In locating these parts on the baseboard as shown, it is important that the individual units be placed so that their terminals coincide with the layout as shown on the separate sheet.

Looking over the top of the panel towards the rear edge of the baseboard



The picture wiring diagram of the audio channel should be compared with the circuit diagram, Fig. 13, for a clear understanding of the connections which are to be made

off in the plate current. If the negative alternation be great, then correspondingly the falling off will be great. If the negative alternation be small, then the falling off will be correspondingly small.

Here, then, we have the same action or results which were produced in the plate circuit of the detector tube. The application of an alternating current to the grid of the tube releases currents in the plate circuit of varying amounts or strengths.

The action between the first audio frequency tube and the second amplifying tube is essentially the same as that just described, the difference being that in the plate circuit of the second audio stage is connected the loud speaker, which is more or less an enlarged or overgrown version of the head phones first used in the plate circuit of the detector stage.

How to Construct a Two-Stage Audio Frequency Amplifier

The parts used in the assembly and construction of the audio amplifier are two Thordason $3\frac{1}{2}$ to 1 audio transformers, two sockets and two type 1A amperites. It is recommended that the

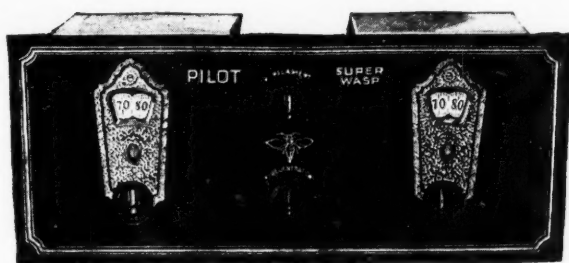
the transformers should be placed so as to have their "Pos. B" and "Plate" terminals to the right side and the "Neg. Fil." and "Grid" to the left.

The sockets should be placed so that the two filament terminals are towards the back, while the grid and plate terminals are to the front. The mounts for the amperites may simply be placed alongside the left side of the sockets.

The position of the new parts should be compared with and aligned with those parts already mounted on the baseboard, such as those for the detector unit. For instance, it will be noted that the amperite for the second audio stage is directly in line with the drum dial. Likewise, the amperite for the first audio stage is directly in line with the "plate" post or terminal of the detector tube socket. The right edge of the first audio transformer is almost flush with the edge of the baseboard, while the second audio transformer is directly behind the de-

(Continued on page 366)

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The Personality Behind the Ghost Hour

(Continued from page 317)

It is entirely mechanical, yet plays chess and checkers, draws selected cards, and acts lifelike in various other uncanny demonstrations. To the writer's knowledge, it is the only automaton in the world that is governed exclusively by mechanical action. Through the kindness of Beatrice Houdini, Dunninger also became the possessor of a large array of spiritualistic records, photographs, and various psychic data, which had been compiled by the late Houdini in his many years of research.

As an author, this man ranks among the foremost in work pertaining to the mystic. Among the books that he is accredited with, are *Universal Second Sight*, *Tricks Deluxe*, *Tricks Unique*, *Popular Magic* (Volumes One, Two and Three), *Houdini's Spirit Exposés*, and *Dunninger's Psychic Investigations*.

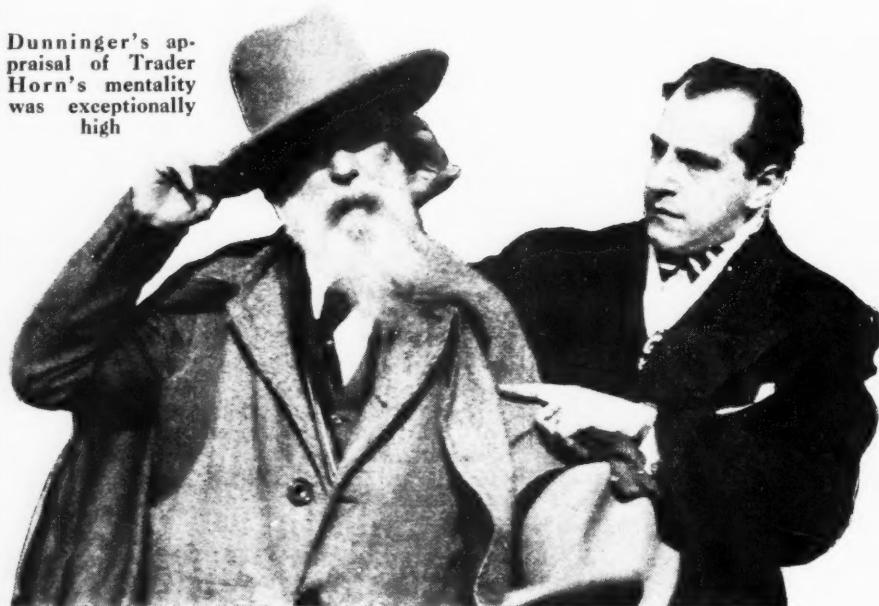
For years this mentalist has been chairman of the Scientific Investigation Com-

produce by his self-styled spirit power.

It is amusing to find how many of the various magazines devoted to spiritualism have been offering accounts of Dunninger's work, and insisting that he is possessed of "spiritualistic power" which he does not in the least admit. Dunninger's scientific demonstrations and constant analysis of the things he does, seems to have absolutely no bearing upon their repeated opinion.

The investigator's daring and fearless attitude might be well expressed in the fact that he recently ventured to appear at a seance at the spiritualist's convention, in New York, and flung a challenge to John Slater, a message bearer, while Slater was demonstrating his so-called "spirit power" before a gathering of over two thousand believers, who were assembled from the four corners of the world. Although the spiritualists succeeded in evicting Dunninger from the auditorium,

Dunninger's appraisal of Trader Horn's mentality was exceptionally high



mittee of *Science and Invention Magazine*, which publication has a standing reward of \$21,000, payable to any medium in the world who is capable of presenting any effect in so-called spiritualism or psychic phenomena which Dunninger would be unable to duplicate by natural or scientific means. Needless to say, hundreds of mediums have applied for this prize, but to date none has been able to offer sincere evidence of psychic ability when subjected to the searching eyes and keen analysis of this investigator.

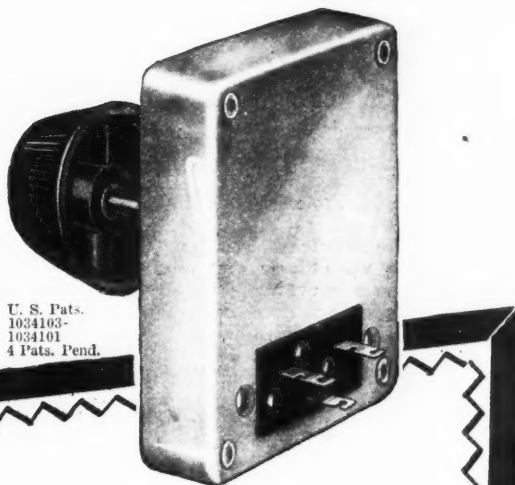
One of the greatest mediums of all time, in the personage of Nino Pecoraro, a young Italian materializing medium, became a subject of Dunninger's investigation, and succeeded in presenting a most impressive seance, in which much of a spooky and uncanny nature was produced. Dunninger, however, easily duplicated all of the medium's wares under similar conditions, and produced much of a phenomenal nature, by scientific means, which even the medium could not

Slater did not succeed in reading a message in a sealed envelope, for which Dunninger offered a reward of \$21,000, and for which he held his check in evidence of his sincerity. The name of Ponzi, the meteoric wizard of high finance, remains vividly in the minds of newspaper readers. Ponzi was for a brief time a master of finance, through whose amazing ability the entire world stood in awe. Dunninger was appearing at Steinert Hall, in Boston, at the height of Ponzi's reign. One of the editors of a Boston paper influenced him to meet Ponzi, and it was through his mental investigation of Ponzi's mind that sufficient evidence was supplied to the authorities eventually to lead to the exposure of this money wizard's methods.

A most interesting experience during Dunninger's career was one in which he was called to assist in the solving of a prominent murder case, of a high police official, in Washington, D. C. He solved,

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The Experimenter

(Continued from page 350)

cathode or the filament to the various points. This is a better connection than using B minus as the starting point. Thus in Fig. 1 "C" the by-pass condenser in the plate circuit of the detector is connected from the plate to the cathode and not to B minus as is often done. Referring to the connections of C1, C2 and C3, there is no alternative.

Connection of Speaker

Concerning the connection of the loud speaker, there are three different choices in a circuit of the type shown in Fig. 1. It could be connected across the choke coil L, and this connection is often used. When this is used, the signal current must go through the eliminator. Common coupling results. It could also be connected from the plate to B minus. The signal current is then forced through

minimum, it may be used to control the volume effectively. It not only changes the grid bias and so controls the volume, but it also varies the total resistance in the plate circuit. Hence, it serves both to vary the bias and to introduce a resistance in the plate circuit.

Operation of Screen Grid Tube

Screen-grid amplifiers are often inserted in receivers in the hope that high amplification and stability will be achieved. Not infrequently the change in the circuit accomplishes neither. The reason is usually that necessary precautions have not been taken. To gain stability with high amplification every precaution must be taken to prevent feedback and to gain high amplification, the proper voltages must be applied. The load impedance must also be high.

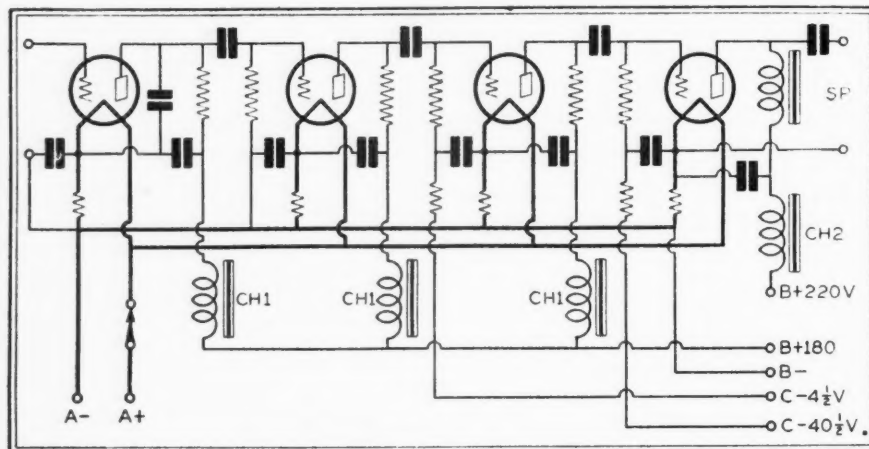


Fig. 3

the grid bias resistor. Reversed feedback results and a decrease in the output, particularly on the low notes where the by-pass condensers are ineffective.

The third method is illustrated in Fig. 1. The speaker returns to the filament. There is no reversed feedback and no signal current through the eliminator, except that which goes through the choke coil. This is small, so the method illustrated is by far the best.

But this connection is not applicable when the output device is a transformer or when the speaker is connected directly in the plate circuit. But in those cases, a large condenser may be connected from the filament to the B plus side of the speaker or the transformer.

Volume Control in A. C. Circuits

One of the difficulties with a. c. circuits is to provide a suitable and adequate volume control. A variable resistor may be placed in the antenna. Usually this is not adequate, although it is very good as far as control of volume is concerned. A very good control is illustrated in Fig. 1. If the variable grid bias resistor R1 is made large enough and has a low

The grid bias should be about 1.5 volts. If the entire filament ballast resistor is placed in the negative leg of the filament and the grid return is connected to A minus, the bias is too high. It is better to put 10 ohms in each leg as illustrated in Fig. 2. If a volume control is put in the filament circuit, it should be put in the positive leg. About 25 ohms is a suitable value.

Stability is achieved by filtering the leads and by shielding the entire stage, not only the tube alone. The connection of the filter condensers is shown in the diagram. Note that all of them are connected to the negative end of the filament. One condenser is across the grid bias resistor, another across the screen-grid and a third across the plate supply. A suitable value for each of these in a radio frequency circuit is .01 mfd.

A radio-frequency choke coil of 85 millihenries is put in series with each of the screen-grid and plate leads.

A necessary condition for high amplification is that the load impedance be high. That is, the primary winding on the coupling coil should be large and it should be closely coupled to the second-

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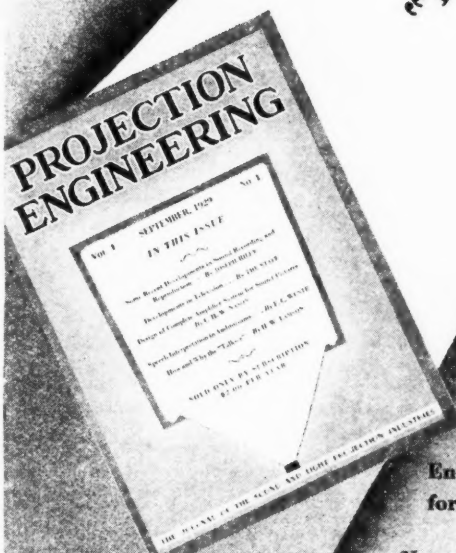
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Recent Developments in Sound Recording and Reproduction

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Television Developments by M. L. Muhleman
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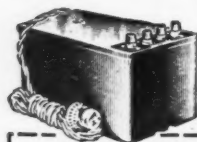
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Motorboating and Howling

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If the trouble is due to feed back, it is difficult to stop. The feed back takes place in most instances through the B battery eliminator or the batteries. When it does it is termed "motorboating" whether or not the frequency is audible.

Motorboating rarely takes place except in the very best amplifiers. But if the B battery eliminator is inadequately by-passed, it may take place in any amplifier having two or more stages.

The remedies for this condition are based on isolating the different stages so that there is no feed back, or on reducing the amplification of the circuit at the frequency of the disturbance.

If the noise is above the middle register, just plain by-passing of the plate leads is usually sufficient. If the disturbance is at a very low frequency, by-pass condensers do not help much. But if the circuit is direct coupled, a reduction of the stopping condenser or of the grid leak resistance is effective. In severe cases both may have to be reduced. Suitable filtering helps. Fig. 3 shows a resistance-coupled amplifier in which a thorough job of filtering has been done to eliminate as much as possible the cause of motorboating.

Placement of By-Pass Condensers

All the by-pass condensers in this circuit are connected to the filament of the tube with which they are associated, and not to the B minus lead. Condensers are not only used in each plate circuit, but also in each grid circuit.

In addition to the condensers, a filter choke is used in series with each plate and a resistor in each of the last two grid leads. These resistors are used because the grid bias is taken from a drop in the B battery eliminator voltage divider. The first three series chokes may be replaced by resistors of about 10,000 ohms. The fourth choke, CH2, should in all cases be a choke of low resistance; it may be of the same type as the coupling choke in the same plate circuit.

The larger the by-pass condensers across the grid and plate leads, the better will be the filtering. It may seem a waste of condensers to some but they are the price of stability and the highest quality. The circuit which has been treated like the one in Fig. 3 will have a response characteristic like the theoretical, and no resistance or impedance-coupled amplifier served by a B battery eliminator will have it, unless the circuit is adequately and thoroughly filtered as illustrated.

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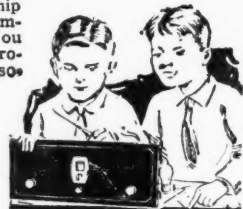
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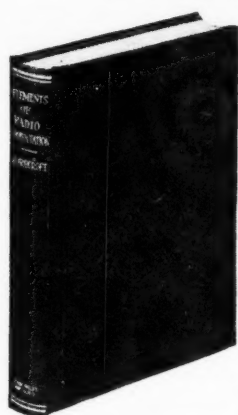
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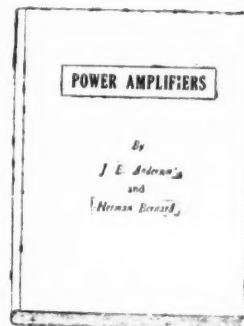
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Here is the first book to be published on the subject of "Power Amplifiers." Now printing. It is certain to fill a void in radio literature. The whole subject is fully covered in a masterful theoretical discussion of audio amplifiers and power supplies, supplemented by constructional chapters, with complete wiring diagrams and specification of parts. Learn while you build! J. E. Anderson, M. A., technical editor of RADIO WORLD, and Herman Bernard, LL. B., managing editor of RADIO WORLD, both of the Institute of Radio Engineers, have explained fully the phenomena of power amplifiers. Learn all about motorboating and its cures, push-pull theory and practice, grid bias methods and effects, vacuum tubes in audio circuits, AC and battery type AF amplifiers, phase relationships, common impedance, filter systems, by-pass condenser effects, necessities for tone-quality, values of coupling constants, and a host of other topics associated with power amplification, including speech amplifiers and "talkie" installations.

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Breaking Into Amateur Transmitting

(Continued from page 322)

graph, the key should be grasped lightly between the thumb, forefinger and middle finger; the other fingers take care of themselves. The round forearm muscle rests easily on the table; the whole arm is relaxed; motion is chiefly confined to the wrist and upper forearm. Another rule of sending, which could be adopted

usually includes diagramming and explaining the operation of your transmitter and receiver (see Figs. 3 and 4). Other electrical queries are usually combined with a few questions about radio law—for instance: No operator may divulge the contents of private messages he may copy; no one shall send out a

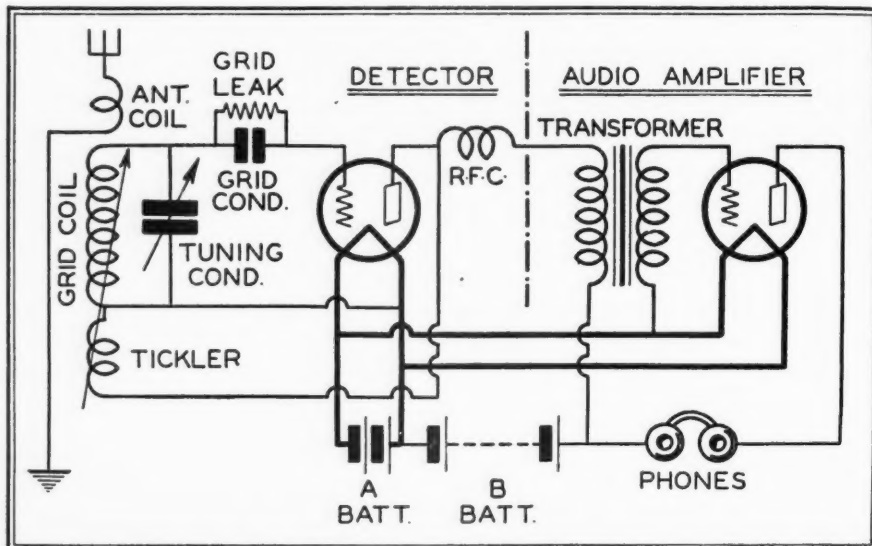


Fig. 4. Another requirement of the Government test is to draw the complete circuit details of your short-wave receiver

with benefit by many old timers, is: send slowly with regular spacing. Slow, even sending will get through a message much faster than a machine gun delivery which cannot be copied.

Licenses

As all radio activities are controlled locally by the Supervisor of Radio, applications for the required operators and station licenses must be made to him. The supervisors are stationed at Boston (1st district), New York (2nd), Baltimore (3rd), Atlanta (4th), New Orleans (5th), San Francisco (6th), Seattle (7th), Detroit (8th), and Chicago (9th). The district boundaries on the map (Figure 2) show at a glance which district you are in. You must make formal application in writing for each license, and for the operator's license pass a code test at ten words per minute and a short theoretical examination as well. This examination

false distress signal; amateurs must stay within their allotted bands and observe evening and Sunday morning silent hours when their transmission would interfere with other services. The two types of licenses are illustrated in the photographs. Though the operator's license happens to be a 1st Class Commercial one, for which a 20 word code test and a theoretical examination lasting several hours are required, the general form and wording of an amateur license is the same.

When a first class receiver has been installed and when the operator is well on his (or her) way toward getting the necessary licenses, it will be time to think of building the transmitter. Here there may be a serious obstacle, usually human, in the form of a father, a wife, or perhaps some more distant yet equally insistent relative. The question arises: is it necessary to submerge everything else around the house in a maze of wiring before signals can be transmitted? The full answer to this question, fortunately negative, will take an article by itself, to appear next month under the title "A Short Wave Transmitter That Fits into the Home."

Radio News at the New York and Chicago Shows

To those of our readers who will attend either the New York or the Chicago radio shows, a cordial invitation is extended to make our booth their headquarters:

SIXTH ANNUAL RADIO WORLD'S FAIR,

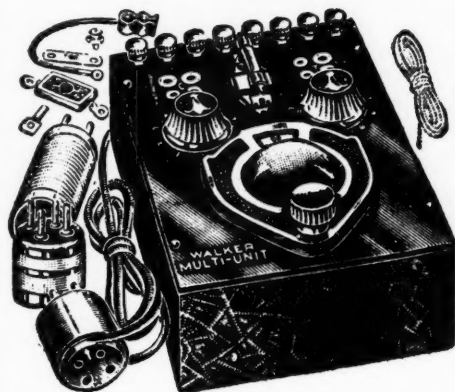
New Madison Square Garden, New York, September 23 to 28 inclusive, RADIO NEWS will occupy booth No. 2, Section II.

EIGHTH ANNUAL CHICAGO RADIO SHOW, Coliseum, Chicago, RADIO NEWS will occupy Booth No. 27, Section H.H.

A Radio Utility and Entertainer

George W. Walker "MULTI-UNIT"

A Device with a Dozen Uses



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| SHORT WAVE RECEIVER | SHORT WAVE ADAPTER |
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One of the most unusual radio instruments ever devised. Will perform any individual function of a complete receiver, and in addition may be used for calibrating, testing or checking. Makes a wonderful broadcast receiver, short wave receiver or transmitter. Oscillates violently over the entire scale range from 550 meters down to 15. Uses all tubes 199 to 210 and all voltages, A.C., D.C., or rectified. Nothing like it ever placed on the market before.

The Radio Fan has at his disposal a device which will provide him with something to tinker with for an entire season without performing the same experiment twice. Become acquainted with all the circuits and the way tubes perform under particular conditions.

The Dealer and the service man require this most valuable instrument for adjusting radio frequency circuits to resonance, providing a beat note or constant frequency oscillation for determining wave length of a particular condenser setting, calibrating a receiver disposing of trade-ins and obsolete sets by making them up to date by the addition of an R. F. amplifier.

NO ANTENNA-GROUND NEEDED

When using the Multi-Unit with most any receiver as an R. F. Booster (extra stage T. R. F.), the sensitivity increase is sufficient to make unnecessary the use of outside antenna. Tone quality is immediately improved. Less external electrical interference assured.

SHORT WAVE CONVERTER (15-95 Meters)

Enjoy the novelty of short wave experiments by converting your present receiver to tune to the low waves. Utilizing the audio amplifier in your own receiver serves a dual purpose and increases volume and range. Plug the unit adapter into the detector socket of your set. No change in wiring or extra tube required. The Multi-Unit will function with either A. C. or D. C. receivers.

R. F. PRE-AMPLIFIER

Uses same type tube as in the R. F. stages of your present receiver. 199, 201-A, 222, 224, 226 or 227 tubes may be used. Either A. C. or D. C. Extreme selectivity, if you prefer. Tune in stations you never heard before. This efficient circuit reduces static and other interference. Greater clarity results as the additional volume makes over-loading of tube filaments unnecessary.

SCREEN GRID R. F. BOOSTER

Increase the range and volume of your present receiver to equal the latest improved Screen Grid Receiver. Merely insert unit adapter plug in socket of your receiver. No change in receiver wiring. Adaptable to either A. C. or D. C. receivers.

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Experiment with the fascinating short waves. Tune to stations thousands of miles distant. Reception of short wave Foreign stations has been verified. Ideal all-year-around reception. Warm weather in Australia and New Zealand is winter in this country. Hundreds of short wave stations throughout the world are listed.

SINGLE TUBE RECEIVER

Ideal for either short wave or regular broadcast band.

SHORT WAVE R. F. BOOSTER

Connect the unit ahead of your short wave set and hear stations with greater volume. Uses screen grid or 201-A type tube.

R. F. OSCILLATOR

Check your receiver for wavelength and calibration. Determine resonance of circuits, test tubes for oscillation and regeneration, neutralizing receivers, balancing condensers, laboratory measurements, short distance transmission and generating a beat frequency for super-heterodyne.

There are numerous additional uses, a few of which are wave meter, Loop R. F. Amplifier and growler for measuring efficiency of shielding material. By the time an experimenter has exhausted the possibilities of this instrument he will be qualified for a radio engineer.

Consists of the essential parts of an oscillatory circuit, and in addition are plug-in coils, adapter cord and plug, bridging connections, and extra wires along with well detailed instructions for many major experiments. Entire unit contained in box 7½ inches by 5 inches by 3½ inches. Price **\$16.00**

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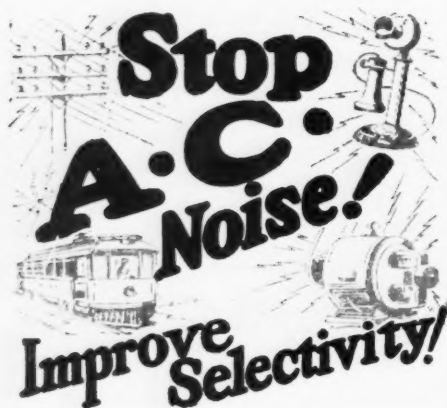
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MAKERS OF
CORWICO BRAIDITE HOOK UP WIRE

(Continued from page 356)

tector tube socket and grid leak mount.

When you are satisfied that you have placed these parts in the correct position they may then be fastened down to the baseboard with woodscrews.

So much for the assembly of the parts.

Wiring the Audio Amplifier

To simplify the description of the wiring procedure, the transformer at the extreme right end of the baseboard will be referred to as Transformer No. 1; the socket to its left as Socket No. 1; the Amperite to its left, Amperite No. 1; the next transformer, Transformer No. 2; the socket to its left, Socket No. 2, and finally the Amperite to its left, Amperite No. 2.

The first step in the wiring job is to wire both grid circuits, then both plate circuits, then both filament circuits, and finally the B and C battery circuits.

First, connect a wire with the terminal marked "Grid" on Transformer No. 1 to the "G" terminal on Socket No. 1. Next connect a wire from the terminal marked "Grid" on Transformer No. 2 to the "G" terminal on Socket No. 2. Then connect a wire from the terminal marked "P" on Socket No. 1 to the terminal marked "Plate" on Transformer No. 2. Connect a wire from the terminal marked "P" on Socket No. 2 to the upper terminal of the Loud Speaker Jack mounted on the panel. Now unsolder the lead attached to the phone tip Fahnestock clip marked "P" and resolder it to the terminal marked "Plate" on Transformer No. 1. The wire connected to the other Fahnestock clip, marked "B plus," is next unsoldered, the clip removed, and the wire resoldered to the terminal marked "Pos. B" on Transformer No. 1. This latter wire is the one which leads to the Yellow terminal on the Cable Receptacle.

Now connect a wire from the "F plus" terminal of Socket No. 1 to the end of the Amperite No. 1 nearest the panel. Connect a wire from the "F plus" terminal on Socket No. 2 to the end of Amperite No. 2 nearest the panel. Next connect the free ends of both Amperites together and continue the connection to the Red terminal on the Connector Cable Receptacle. Then connect both "F minus" terminals of the sockets together and continue the connection to that side of the Filament Switch, mounted on the panel, to which is connected the wire leading to the "F minus" terminal on the detector socket. This particular switch terminal can be easily identified because it is the one that does not lead to the Black terminal on the Connector Cable Receptacle.

To complete the B battery circuits it is necessary to connect a wire from the terminal marked "Pos. B" on Transformer No. 2 to the Blue terminal on the Connector Cable Receptacle. Then connect a wire from the other vacant terminal on the Loud Speaker Jack to the Gray terminal of the Receptacle.

The Thrill of My Life And How I Gave It to Others

Several weeks ago I visited an old school friend of mine, whom I hadn't seen for several years. After chatting a while, she asked me if I had ever been to a spiritualistic meeting. I said, "No, but I'd like to go."

So she took me over to a friend of hers whom she said was a medium that could actually show me spirits, talk with them, and receive messages from them about the dead.

Of course, I didn't believe it, but I sat down in a darkened room with several others.

All of a sudden tables began to jump, lights flashed, grave voices spoke and ghosts appeared before my very eyes. For an hour this went on, my hair standing on end half the time, and the other half I tried to control myself to keep from running.

When it was all over I wiped the perspiration from my brow, fully convinced that spiritualism was the real thing, and walked out into the open air thrilled to the very marrow of my bones.

As we started for home, my friend began to chuckle. Very indignantly I asked her what she thought was funny, for my knees still trembled. But she said not a word until we arrived home, then pulling down a big book from her book-shelf she handed me "Houdini's Spirit Exposés," and as I glanced through the beautifully illustrated pages I realized that I was a victim of a huge joke. For everything the "medium" did was clearly explained within this one volume, with dozens of other stunts that one could easily do. Houdini, the world-famous magician, has merely set down all the tricks of his trade in one huge volume, and these tricks were reproduced to give me my thrill.

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Now, the terminal on Transformer No. 1 marked "Neg. Fil." connects to the green terminal on the receptacle, while the similarly marked terminal on Transformer No. 2 connects to the brown terminal on the receptacle.

The grid and plate connections need take up only a small space between the units; in fact, the less space the better. The filament, B battery and C battery circuits, the latter connecting to the "Neg. Fil" terminals on the transformers may all be arranged neatly in cable formation along the rear edge of the baseboard. To keep these wires in place they may be bound with cord, but care should be exercised in this stage of the work to see that the cord does not cut the insulation covering the wire so as to cause possible short circuits.

Operation

After the wiring is completed the receiver is ready to operate as a three tube set. The signals will be loud enough to operate a loud speaker, and, when the proper values of B and C battery are used, as specified in Fig. 9, appearing in Lesson Number Two. (Radio News for September, 1929, Page 247), together with the correct vacuum tubes, a very fine tone quality of sound reproduction will result. In the first audio stage (Socket No. 1) a type 201A tube should be used. In the output stage (Socket No 2) a type 112A tube should be used.

To operate the receiver, assuming that all the batteries are connected to their proper wires, insert the amperites in their mounts, then insert the tubes in their respective sockets.

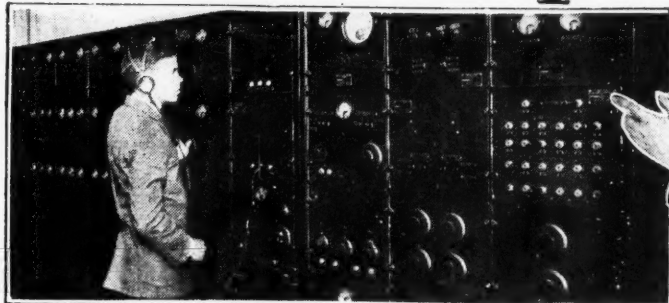
When the filament switch is turned on and a station tuned in, the music or speech will be many times louder than that heard in the phones with only the detector unit working. Since there are no variable features about the two-stage audio amplifier unit, no adjustment of it is required to keep it in satisfactory operation. Simply tune and operate the set as you did when you had only the detector unit.

Erratum Notice

In our September issue we published an article (p. 231), "Dr. Lee DeForest Writes the Reminiscences of a Radio Pioneer." There were several interesting illustrations, in that article, of some of Dr. DeForest's early experiments.

In view of the fact that the editor of *Radio Broadcast*, Mr. Willis K. Wing, was kind enough to lend those illustrations to us, we should have made the usual acknowledgment. Since this was omitted through an oversight, we take this opportunity of calling attention to the omission, acknowledging our obligation to *Radio Broadcast*, and sincerely apologizing to Mr. Wing.—THE EDITORS OF RADIO NEWS.

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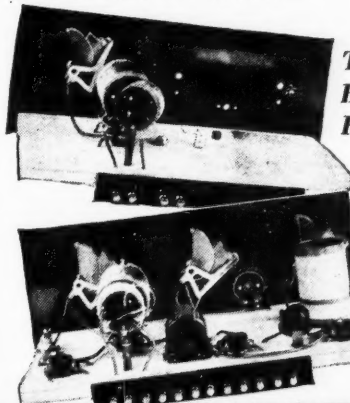
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I give you a home experimental laboratory. You can design and build 100 circuits with it. Here are two—



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What Is a Good Loud Speaker?

(Continued from page 319)

are combined to produce a useful device.

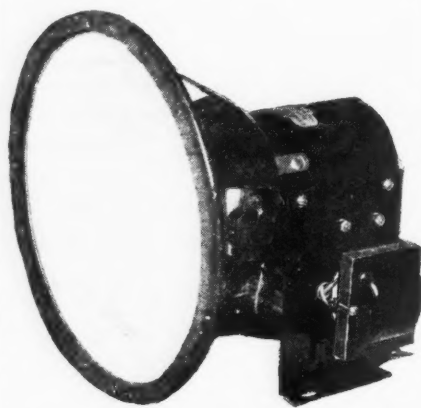
A picture diagram showing the construction of an ordinary dynamic loud speaker is given in Fig. 3. The loud speaker consists of the following essential parts:

- (a) the cone.
- (b) the moving coil.
- (c) the centering strips.
- (d) the coupling transformer.
- (e) the magnetic core.
- (f) the field coils.

If one knows what to expect when examining a dynamic loud speaker, it is much easier to form some opinion regarding it. Let us examine in some detail the design, purpose and construction of the various sections listed above.

The Cone

The cone is usually made of a stiff paper formed into a conical shape so that maximum rigidity with a minimum of weight is obtained. The paper must be such that it does not alter in shape or size due to temperature variations and it must not be affected by dampness. The paper must not be subject to fatigue—these characteristics in the paper are essential if the loud speaker is to give long, useful service.



To energize the field coil of the dynamic, various power supplies are employed

Until quite recently paper was the only material used in the construction of cones of any type. At present, however, the writer knows of one special material designed specially for use as a diaphragm material in dynamic loud speakers. It is known as Burtex and is used in a number of dynamic loud speakers. Its makers claim that it is unaffected by the weather and that a more efficient loud speaker with a somewhat better frequency response can be constructed by the use of Burtex. It's possible that there are some other special diaphragm materials on the market with which the writer is not familiar and which also have advantages over paper.

The angle at which the cone is formed is quite important. It determines the stiffness of the diaphragm and it also alters to some degree the frequency re-



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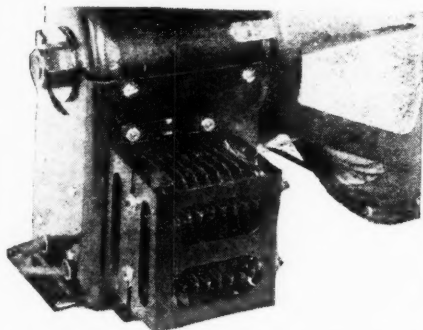
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sponse characteristic of the loud speaker. The cone, small though it is, acts, at high frequencies, like a small horn. The larger the angle the smaller is the horn effect, but with large angles the cone is less rigid, which affects the efficiency and the low frequency response.

The cone is supported at the outer circumference by a strip of some soft, pliant material such as thin leather. It is essential that this supporting material be light and flexible so that it will not hinder the movements of the cone.

The Moving Coil

The position of the moving coil is clearly indicated in Fig. 3. The coil is generally wound on a support made of some thin insulating material which, in turn, is cemented fast to the paper cone. In the case of a diaphragm made of Burtex the support for the coil is part of the cone itself.



The dynamic shown here employs a stepped-down 110-volt line source rectified by the dry rectifier illustrated

The number of turns used for the moving coil may be anything from one up to several thousand. Generally, however, the coils consist of about one or two hundred turns of fine wire, about No. 35 gauge.

The coil and its support must move axially to and fro in the air gap during operation of the loud speaker and it is therefore essential that the coil and its support be accurately centered in the air gap and that means be provided to maintain it in this position. In some models a thin spider web form is used for this purpose. Other dynamics make use of three light thin springs which serve to hold the moving coil accurately in the center of the gap and permit no movement sideways although permitting very free movement in the direction of the axis of the cone. The major requirement of the centering device is that it be stiff enough to accurately keep the coil centered but that it not interfere with the normal movements of the cone.

Some dynamics using light springs to center the coil also use these springs to convey the current to the moving coil. In other models current is supplied to the coil via two fine wires cemented along the cone.

The Coupling Transformer

The moving coil system of a dynamic loud speaker has, generally, quite a small electrical impedance. At low frequencies
(Continued on page 370)



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(Continued from page 369)

the impedance of the average dynamic is something in the neighborhood of 10 to 25 ohms. If the loud speaker were ideal this impedance would be constant and of pure resistance at all frequencies. Actually the impedance of a moving coil speaker varies with the audio frequency, gradually increasing in value with increases in frequency.

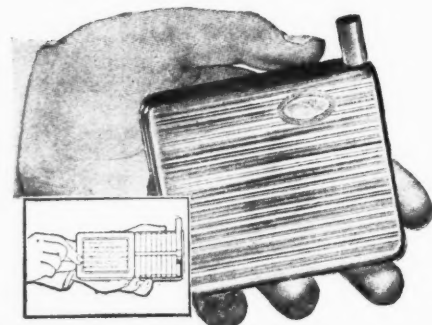
At all audio frequencies the impedance of the average moving coil system is, however, much lower in value than the plate impedance of a power tube, and for this reason a coupling transformer must be used to adapt the impedance of the moving coil system to the plate impedance of the power tube. If we were to try and operate a dynamic loud speaker without any coupling transformer between the tube and the moving coil, we would find that the volume would be very low and that considerable distortion would be produced.

Coupling transformers as used in the ordinary dynamic loud speaker are generally designed to operate satisfactorily with any ordinary type of tube. In such cases somewhat increased efficiency would be obtained through the use of a special coupling transformer designed to operate satisfactorily with any ordinary type of tube. In such cases somewhat increased efficiency would be obtained through the use of a special coupling transformer designed to work with the particular tube to be used. At least one manufacturer, the Silver-Marshall Company, get around this problem very nicely by using a transformer with several taps on the primary so that the proper ratio for most efficient operation can be obtained no matter what power tubes or arrangement of power tubes the loud speaker might be supplied from.

The Iron Core and the Field Coils

The operation of a dynamic loud speaker depends upon the reaction of two magnetic fields, one due to the audio currents flowing through the moving coil and the other due to the currents flowing through the field winding set up a steady magnetic flux throughout the field circuit. The part of this flux which is useful is that part which passes across the air gap where the moving coil is located. It is at this point that the field flux reacts with the currents in the moving coil to cause the coil to move. The larger the audio currents through the moving coil and the greater the value of the steady flux due to the field, the greater the movement of the cone and therefore the greater the sound produced. It is of advantage therefore to get in the air gap as high a flux density as possible. Commercially, the loud speaker manufacturer designs the units for maximum flux density consistent with reasonable cost and a reasonable amount of power consumption from the source supplying the field power.

Power to supply the field may be obtained from a storage battery, from the filter system in a B power unit, or from the light socket. In the case where the



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light socket supplies a. c. the loud speaker is equipped with a rectifier so that d. c. is available for the field circuit.

This completes the technical discussion of the dynamic loud speaker. If it has accomplished what we hoped it would, the reader will have obtained from the preceding discussion a good idea of the relation of the various parts used in a dynamic loud speaker.

It is only when one has some idea of the general design, construction and purpose of the various parts of any device that one can properly compare one loud speaker with another. A man who goes into a radio store and says "I want a set" and then after listening to a half dozen decides to buy some particular one is very much like the traveler who goes on one of those "personally conducted" tours. He sees and hears what is shown to him—he never knows what he may be missing! The traveler—and the radio experimenter—who gets to know all the by paths is the one who gets off the beaten path and sets out for himself. He may bump his shins but in the end he has a good time and the satisfaction of having found out things for himself.

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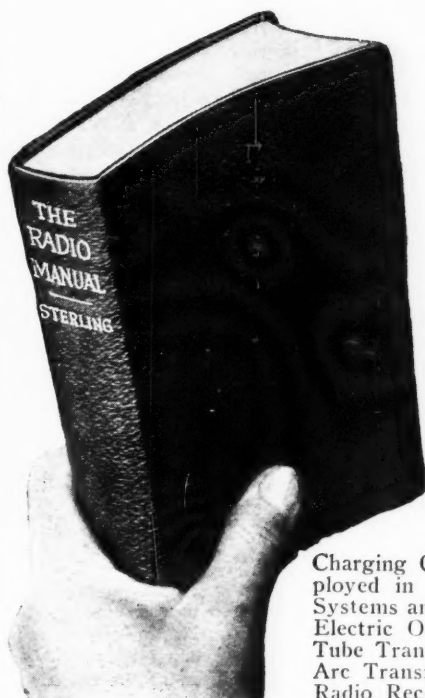
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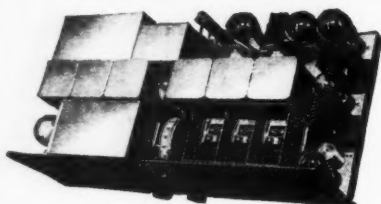
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Building the Seven-Tube Magister Tuner

(Continued from page 308)

time they are clamped or pressed between two boards to remove the excess cement and to make them of uniform thickness. This thickness will be the same as the width of the bakelite rings.

After the slot wound coils are hard and dry, they are assembled on one inch diameter tubing three inch long. The tubing is split and a $\frac{1}{8}$ inch section removed along its length. The coils may be easily slipped over the tubing by springing the one inch diameter tubing together. Two coils with their respective bakelite cores are slipped over the tubing as described above. Care should be exercised that the windings of both coils are in the same direction. This type of mounting permits adjustment of the coupling between coils, the slotted tubing springing outward and holding the coils in the adjusted position.

These band filter transformers are provided with lug terminals as also provided for the other coils described above. The bottom coil is used for the primary while the top coil is used as the secondary. The "outside" of the secondary coil connects to the grids of the tubes and is designated as "O." The "inside" of the secondary, designated "I," is connected to "B" minus. The "inside" of the primary "I" is connected to the plate while the "outside," designated "O," is connected to "B" plus 180 volts.

The antenna, oscillator, r. f., and band filter transformers are provided with brass or thick aluminum mounting brackets as shown in the detail sketch.

Making the Chassis

Seven feet of one inch angle brass $\frac{1}{8}$ inch in thickness is used in the construction of the chassis frame. This material is cut to lengths of 29 inches and 10 inches respectively. Two of each are required. The ends of the angle brass are cut to a 45 degree angle on the surfaces to be used as the top of the frame. The iron corner pieces as mentioned in the list of parts (these are obtainable from any hardware store) are placed in proper position. The positions of the holes to be drilled and tapped for 8-32 screws are marked, after which the angle pieces are drilled and tapped. The ends of the angle pieces are butted together tightly and the resultant rectangular frame should have perfectly square corners as otherwise the chassis will be lop-sided. This construction is shown in detail in the drawings of Fig. 5. To further strengthen the frame the iron corner brace pieces are soldered to the brass angle pieces. An additional piece of flat metal is soldered to the under surface of the brass angle directly over the joint for better re-enforcement. This work results in a very strong frame and support which is greatly desirable for a receiver of these dimensions.

Assembly of Shield Compartments and Partitions

After the chassis frame has been made,

a single sheet of aluminum 3-64 or 1-16 inch thick is cut to fit the top of the chassis frame. This serves as the bottom of the shield compartments as well as the common electrical connection when wiring the receiver.

The positions of the various slotted corner and partition posts holes are spotted, as shown in Fig. 5, on the bottom plate and drilled. The bottom plate is then placed in position on the chassis frame, the position of the holes marked on the frame which is in turn drilled. Care should be taken in spotting the position of the corner and partition posts, that they are square with the frame, as otherwise the shield compartments will be out of line.

The frame, bottom plate, corner and partition posts are now assembled together. This is accomplished by passing 6-32 machine screws through the holes of the chassis frame from the under side, through the holes in the bottom plate and screwed into the tapped holes at the ends of the posts. This makes a very neat and professional appearing assembly job.

The ten inch partitions are now slipped into place as shown in the picture diagram. Also the partition separating the i. f. compartments from the oscillator compartment. The inter-compartment partitions are now measured as to exact width, allowing $\frac{3}{8}$ inch on each side for the turned over edges. It is wise to spot the positions of the fastening holes in these turned over edges and drill them before bending. After the inter-compartment partitions have been drilled, the turn overs are bent, trying not to warp the material any more than necessary in the bending process. These partitions are then placed in their respective positions, and the position of the holes in the turned over edges marked on the ten inch partitions, and drilled. This applies as well to the partition separating the first i. f. compartment from the drum dials and the partition separating the second i. f. from the power detector compartment. The three aluminum pieces for shielding of the band filter transformers from the chokes and screen-grid tube are now cut to size allowing $\frac{3}{8}$ inch on each side for the turn over edges. These pieces are then bent into shape. When fastened into place these will make shield compartments 3 inches square.

Four of the ten inch partitions are also drilled for $\frac{1}{2}$ inch holes to allow the passage of the condenser shafts thru each compartment to the drums.

Mounting Variable Condensers And Drums

The positions of the variable condensers are now marked on the bottom plate. To expedite matters it would be convenient to scribe the exact dimensions of each compartment on the bottom plate.

The type F drum dials are now placed in position. The projection on the bottom of the drum support frame is re-

On Short Waves

(Continued from page 352)

in phase with each other, the tickler coil is in the feedback position and will add to the resultant signal strength. The feedback from the plate circuit to the grid circuit is at radio frequencies, therefore, a by-pass condenser is connected from the lower side of the tickler to the filaments.

In Fig. 4 is shown another method for controlling regeneration. For short wave receivers, the action resulting from the use of this method is somewhat smoother than that shown in Fig. 3. The variable resistor has a maximum resistance of 500,000 ohms and may either be connected in series, as indicated, or in shunt at the points marked X, X. When employing the variable resistance method for regeneration control, the secondary

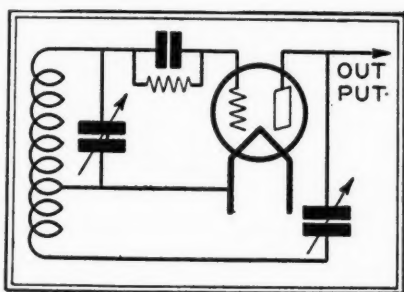


Fig. 6

and tickler coils are wound on the same form, a space usually separating the windings from each other about $\frac{1}{4}$ ". Many variable factors enter into a calculation for the number of turns for a tickler. A general rule may be used, of a secondary and tickler turn ratio of 1 to 1 for the lowest wavelengths, increasing the secondary turns to $2\frac{1}{2}$ to 1 at 100 meters.

The method for controlling regeneration employed by a number of short-wave code receivers is shown in Figs. 5 and 6. Here a variable condenser is used as the regeneration control medium. In Fig. 5 a variable tickler is employed and after once being set need not be readjusted till such a time as some major change is made in the detector stage of the receiver. All feedback tuning is accomplished on the variable condenser. One precaution is necessary, being the connection of the rotor plates of the variable condenser to the tube filament circuit. In Fig. 6 the tickler is stationary, being wound on the same form as the secondary. The control condenser affords all necessary control of the feedback. Very little, if any, trouble will be experienced in either the variable resistor or the variable condenser regeneration in the logging of the grid turning circuit, as neither of these methods has the disadvantageous effect of that of the rotating tickler. Various other methods of providing regeneration may be used, such as, the link circuit, variable split winding and plate variometer. These forms of controlling regeneration are not practical for short-wave receivers, so they will not be discussed here.

Experiment with the various systems outlined here will tend to illustrate each one's own peculiarities, advantages or disadvantages.

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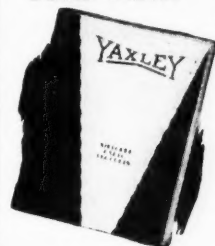
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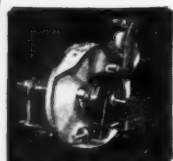
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moved with a hacksaw. The drums are separated by a distance of approximately $\frac{1}{2}$ inch, and each is mounted approximately $1\frac{3}{4}$ inches on center on each side of the center line of the chassis. This line is approximately $14\frac{1}{2}$ inches from either end of the chassis. The positions of the holes in the drum support frame are marked and drilled thru the bottom plate and chassis frame. The drums are fastened to the chassis by screws placed through from beneath the chassis frame and bottom plate, and are then screwed into the tapped holes of the drum support frame.

The condensers are next mounted. A line is scribed along the length of the bottom plate to the same distance from the front edge of the chassis as that measured from the edge of the chassis to the center of the drum shaft sleeve. The positions of the holes in the cast aluminum frames of the condensers are marked on the above line. The condensers should be centered in the r. f. compartments, and the oscillator condenser should be placed approximately one inch from the partition separating the condenser from the drum dial compartment. Brass pillars of such height to center the condenser shafts with the drum shaft sleeve, are placed under the condenser frames. The condensers are now fastened solidly in place. After which the condenser shafts are placed through the condensers and drum dials.

Mounting the Coils

The various coils are now mounted in their proper positions in their various compartments. This work should be done before the shielding is assembled as it is more convenient to mount and wire the parts into the circuit as the shielding is assembled. This is especially true in respect to L3, L5, L6 and L7. The mica variable condensers for tuning the primaries and secondaries of the band filter circuits should also be mounted before mounting the band filter transformers.

The r. f. chokes are all mounted in the upright positions shown. Various positions or locations for these were tried before the positions as shown were found satisfactory.

Mounting of Additional Parts

The sockets are now mounted in position. In mounting these it is advisable to raise them from the bottom plate by washers $\frac{1}{8}$ inch thick. This work will eliminate possible shorting of the prongs with the bottom plate, especially if the solder should happen to run down. It would also be advisable to raise the variometers from the bottom in the same way. The author has learned to never invite trouble in this respect. The variometer (C29) shunting the oscillator variable condenser (C4) is mounted near the variable condenser as shown. The purpose of the variometer (C29) is to allow adjustment of the variable capacity, in relation to the inductance of the oscillator coil, to a scale reading nearly the same as the r. f. scale. Its use is not entirely necessary. Should the builder

desire to eliminate it, the grid or secondary winding of the oscillator coupler should be increased from 55 to 60 turns. The 1 mfd. by-pass condenser (C28) is now mounted in the oscillator compartment in the position shown.

The power detector bias resistor is mounted in the detector compartment. The midjet detector plate by-pass condenser (C26) is also mounted at this time.

The two volume controls (R7 and R8) are fastened to the front sections of the shield compartments as shown. The latter resistor must be insulated from the metal. The by-pass condensers with the exception of (C26) and (C28) are mounted underneath the bottom plate. The grid suppressors used as bias resistors (R1, R2, R3, R4, and R5) are soldered to one lug of their respective by-pass condensers (C11, C14, C17, C19 and C22) the other sides soldered to the brass frame. The exact values of the bias resistors depend upon the tubes on which there is a discussion in another paragraph.

The binding posts are now mounted, B1, B3, and B4 are insulated from the shielding. There are many ways of accomplishing this and therefore is not described here.

Wiring

In wiring the receiver it is advised that all high potential leads be wired first. This applies particularly to the grid and plate leads. These leads must be as direct and as short as possible. To further prevent feedbacks it is necessary to shield the grid circuit of each tube from its plate circuit as recommended by tube manufacturers. This is accomplished by using hollow metal braid, any of the various varieties on the radio market will prove satisfactory. The wire braid should of course be non-magnetic.

Beginning with the modulator, each compartment is wired completely, after which the partitions are fastened in place for that particular compartment. This procedure is carried out for each of the r. f. compartments. Beginning with the modulator compartment again, the i. f. transformers and their tuning condensers are wired, placing the shielding partition in permanent position after each is completed.

The balance of the wiring, composing the plate, screen grid "B" supply returns from their respective chokes, the negative and by-pass condenser returns are made in the order given. The a. c. supply for the tube heaters and the power switch are wire in last.

Preparing the Aluminum Cover

The cover for the aluminum compartments is made from a single sheet of aluminum $27\frac{3}{4}$ inches by 10 inches by 3-64 or 1-16 inch thick. The holes for fastening the cover to the corner and partition posts are spotted on the cover and drilled. The position of the tube port holes is marked and cut out with either a circular cutter or by scribing a circle in the proper position and drilling

cut with a succession of small holes drilled around the circumference, after which the small jagged edges are filed down with a round or half round file. The diameter of the port holes will be determined by the size of the port or caps. The author visited the 5 and 10 store and purchased seven of the large size aluminum shakers, the sort used by the kitchen help. These shakers had a diameter of $2\frac{1}{4}$ inches and were about the same height. A beaded rim or shoulder is found around the circumference about $\frac{5}{8}$ inch from the bottom of the shaker. This raised shoulder served to prevent the cover from sliding through the port holes of the cover. The top portion of the shaker was removed to within $\frac{3}{8}$ inch of the shoulder. It was also necessary to remove the end of the aluminum handle from the part of the shaker used as the cap. This was done by filing down the head of the aluminum rivet until the handle was loosened.

Tubes Used in the Receiver

Using the new speed 224 type tubes the bias resistors (R1, R2, R3, R4 and R5) must have a value of 750 ohms. This value of resistance is an odd size with most manufacturers but the value was easily obtainable by placing two 1400 ohm wire wound resistors of the grid suppressor type in parallel. If the old type 224 is used the value of the bias resistor must be 375 ohms for normal rated operation.

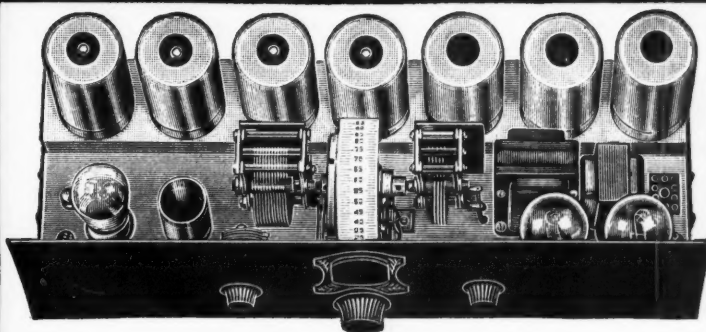
The Speed 227 type tube, of the quick action heater type, was found to be a very efficient oscillator when used in the "Magister" circuit.

Adjustment of the Receiver

When the wiring of the receiver has been completed, do not be afraid to test the receiver for shorts or other possible incorrect connections. When the builder has assured himself that the receiver is properly wired, the various power supply leads of the receiver are connected to the indicated voltages on the power supply unit. The antenna and ground are connected. A 250,000 ohm. resistance and one side of a 1 mfd., by-pass condenser are connected to the detector plate binding post. One terminal of a pair of phones is connected to the remaining side of the condenser. The remaining terminal of the phones may be connected to either the detector cathode binding post or to the remaining open end of the resistor. This end of the resistor is also temporarily supplied with from 135 to 180 volts from the power unit.

Provided the inductance of the r. f. secondaries are nearly the same, as well as the variable condensers (matched condensers in sets of three may be obtained from the manufacturer), no compensation of these stages will be necessary other than to set the condensers at their maximum capacities and tightening the rotors to the shafts by the set screws provided for that purpose. At this time the oscillator condenser shaft may be fastened and then both drums adjusted and tightened at their maximum scale indication.

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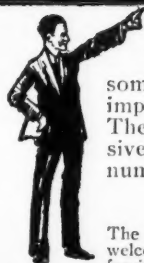
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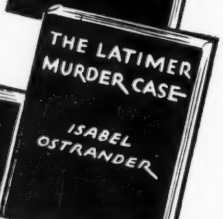
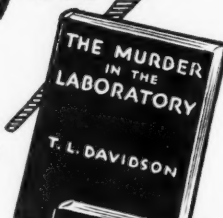
On the side of a road they found him—in the spring mud of Illinois. He'd been shot in the back of the head three times—but there didn't seem to be a single clue. Yet, when they discover he was the outcast son of a millionaire, Michael Thomas, famous Chicago Detective, is put on the trail. A story of the Illinois Underworld, and its rise since the World War.

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The adjusting screws of the variounders are now tightened (don't force the screw as this might break the device), after which each is loosened $1\frac{1}{2}$ turns. The power switch, mounted on the volume control (R7) shaft is turned on. Each tube is inspected for heater action, a dim light should be noted. After a few seconds the r. f. drum is slowly rotated, meanwhile rotating the oscillator drum over a scale section of approximately 30 degrees. If the oscillator is functioning, all tubes perfect, a broadcast signal should be heard in the phones although the signal may be very weak.

If no signal is heard the oscillator tube should be observed for oscillation. This may be accomplished by inserting a pair of phones in the "B" plus return. Touching the grid and plate terminals of the socket with a wet finger tip, a plop should be heard on the placement and the removal of the finger will indicate oscillation, providing the action is observed on both the grid and plate. In rare cases it may be necessary to increase the number of turns in the plate coil of the oscillator coupler. The number of turns in this winding must always be kept as low as possible. In some cases the plate winding may be reversed and must be connected properly. If the coupler is constructed according to the detail drawing and to the description, there is no possible chance of the misconnection.

When the oscillator is functioning properly and a signal is heard in the phones connected in the plate circuit of the detector, the variounders with the exception of C5 and C29, are adjusted for loudest signal. The coupling between the band filter transformer primaries and secondaries should be approximately $1\frac{3}{4}$ inches. If these coils have been properly matched no difficulty will be experienced in obtaining a definite resonant peak by the adjustment of the variounders. By further adjusting the coupling between the coils the frequency of hand-pass may be obtained very effectively. It may be found necessary at this time to re-adjust (C5). If this condenser is re-adjusted it will become necessary to readjust the other variounders again as described.

The variounder (C29) shunting the oscillator variable condenser is now adjusted to bring the scale reading of both drums nearly the same. The builder is cautioned against rapid rotation of the tuning drums as it is very easy to pass over even the most powerful broadcast signal. When the receiver is in perfect working order the author hopes that the builder will obtain the same pleasure and develop the same enthusiasm, after pulling in station after station, DX and locals of various power, from one end of the tuning scale of the drums to the other. After proficiency of tuning is developed the builder will be able to pull in greater or Super-DX with ease. The author would be very glad to hear from "Magister" builders and owners. He will also endeavor to answer any questions concerning this receiver collectively through the medium of RADIO NEWS pages from time to time.

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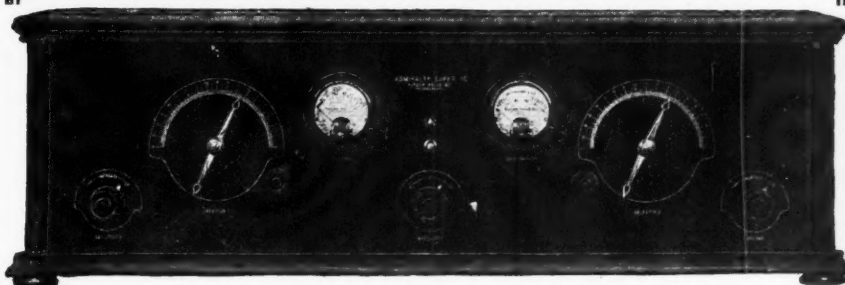
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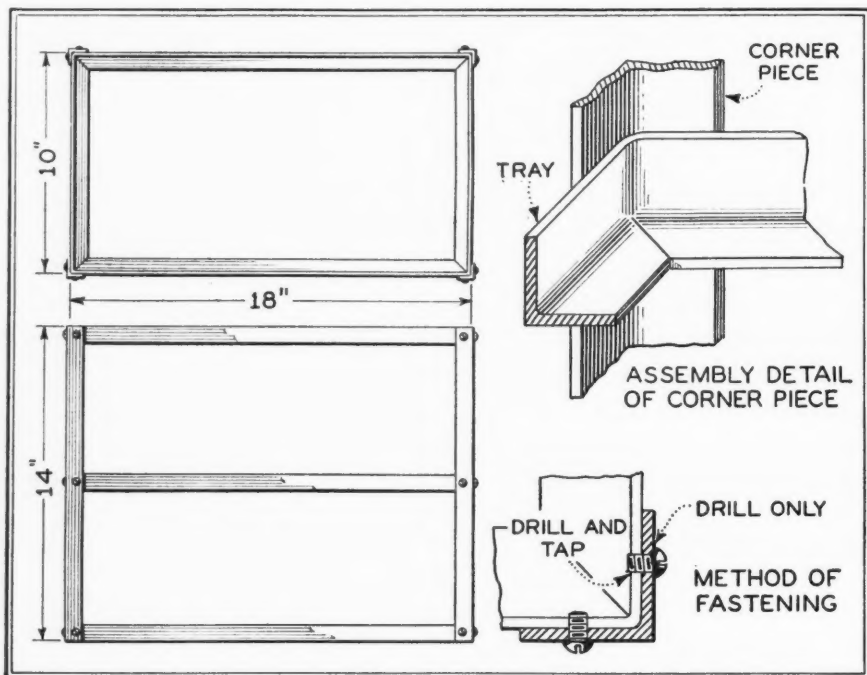
The Compact Flexible Speech Amplifier

(Continued from page 328)

ceiver through the switch JSN2 on the amplifier panel. If the filaments in the receiver are to be a. c. operated, a double pole, double throw snap switch should replace this switch, one side to be used for the bleeder circuit and the other for the 110 V. a. c. supply to the receiver filament transformer. The use of a storage battery for the r. f. filament is desirable in some cases where it is necessary to keep hum down to a minimum.

The resistance R1 in the power supply unit is equipped with semi-adjustable taps to provide any desired combination of plate voltages for the receiver. The output transformer incorporated in the am-

plifier network, R1, be adjusted before the assembly of the case has been completed. To make these adjustments the receiver, phonograph and the speaker should be connected up so that a complete operating test can be made. All tubes should be put in place in the receiver, and a 112A, a 350, and a 381 should be placed in their respective sockets in the amplifier unit. Then after making sure that the main control switch SW1 is turned to the "off" position, the amplifier may be plugged into the a. c. line. Next, the knobs controlling the C bias resistors R2 and R3 should be adjusted to their center positions and the milliammeter plug in-



A sketch showing the framework of the amplifier

plifier is designed to feed into a dynamic speaker. A different type should be employed for use with magnetic speakers. Where two dynamic speakers are to be employed, it will be found best to connect them in series. In the case of magnetic speakers, if several are to be employed, they should be connected in series-parallel groups so that their total impedance will be equal to the impedance of a single speaker, or as nearly so as is possible.

There is no necessity for a verbal description of the construction of this amplifier. The very complete illustrations will provide all of the information necessary to an experienced constructor. However, some suggestions regarding the proper adjustment of the unit will be helpful.

Adjustment and Operation

Assuming that the construction and wiring have been completed, it is necessary that the taps on the output resistance

serted in J2 ready to provide a reading of the plate current for the 350 tube. The receiver filaments may now be turned on in readiness for operation, and finally the main control switch SW1 may be turned on.

Immediately upon turning the amplifier on, the knob of the grid bias resistance for the 350 tube should be adjusted to show a plate current reading of 55 milliamperes. This immediate adjustment is made to avoid the possibility of damaging the tube by applying excessive current due to improper grid bias. The taps of resistor R1 are adjusted by first loosening the set screws and sliding the metal bands along the resistor unit. When in proper position they may be permanently fastened in place again. In order to make these adjustments a high resistance voltmeter is needed. This is first connected across the 135 volt tap and this tap adjusted to provide a 135 volt reading on the voltmeter. Then the other taps are similarly adjusted, one after the other, until the plate voltages

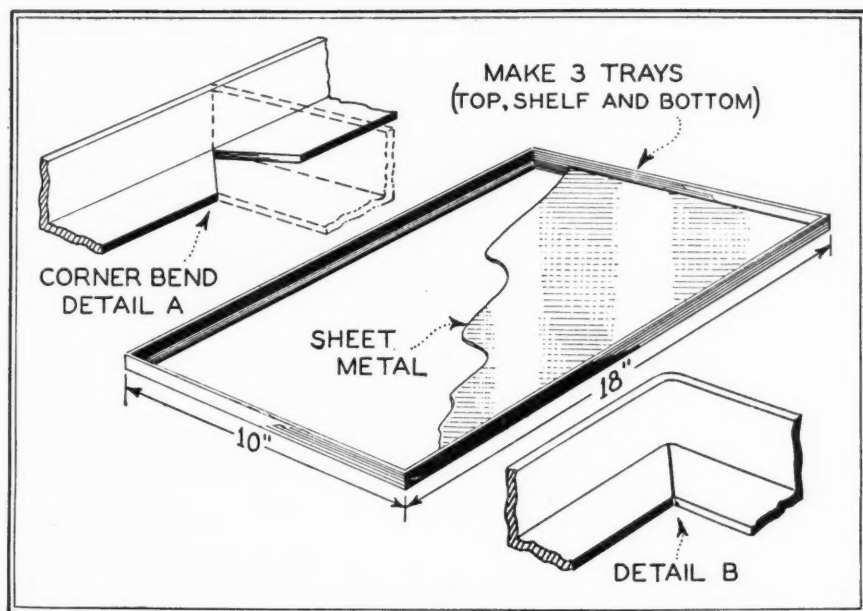
required by the receiver and first stage audio tubes have been exactly adjusted. Next, connect the voltmeter across the resistor R2 and adjust the knob of this resistor until the meter shows a drop of nine volts, which is the bias required for the 112 tube with a plate voltage of 135. At this point it is advisable to again check the 135 volt tap to make sure that it has not been affected by the adjustment of the C bias.

The C bias for the power tube is measured by connecting the voltmeter directly across the portion of resistor R3 that is actually in the circuit. With the knob of this resistor adjusted to show a plate current of 55 milliamperes, the voltage reading across the biasing resistor should be very close to 84 volts. If at this current drain the bias voltage reading is 90 volts or higher, it is an indication that the 350 tube plate voltage (measured from the 350 tube filament center tap to the plate of this tube) is higher than the required 450 volts. Such excessive voltage may be the result of employing a receiver with very low plate current drain and may be corrected in one or two ways.

The first method is to connect a variable heavy duty resistance in series with

which most of the receiver plate current is drawn. This will usually be the 90 volt tap, although in the case of a superheterodyne receiver it may be the 45 or 67 volt taps. If this resistance is left connected as shown in the schematic diagram, it will have a tendency to change the voltage on the plate of the first amplifier tube when the receiver is turned off but the amplifier left in operation. Inasmuch as this resistance is provided to compensate for receiver current drain, it is only logical that it be connected to the tap providing the greatest current to the receiver. The simplest method for adjusting this resistance to absorb the exact amount of current drawn by the receiver is to plug the milliammeter into J1 while the receiver is in operation. Note the milliammeter reading. Then turn off the receiver by means of the switch JSW2 and adjust the bleeder resistance until the milliammeter again shows the same current drain.

It may be desirable to arrange the complete installation in such a way that the main control switch SW1 of the amplifier will control not only the amplifier, but also the field supply to dynamic speakers and perhaps an a. c. supply to the receiver



A detailed drawing showing how the corners and frame for the trays are constructed

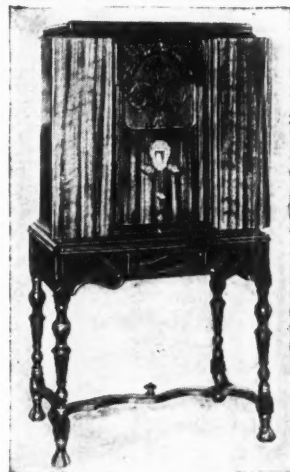
the high voltage side of the rectifier output between the rectifier and the first filter condenser, C3. This arrangement has the advantage that the excess voltage will not be applied to the filter condensers. However, a more convenient and quite satisfactory method of reducing the high voltage is to take the power tube plate supply off next to the highest tap of the resistor R1, moving this tap to provide the correct voltage.

The bleeder resistance, R5, is next adjusted. In the schematic diagram the high potential end of this resistor is shown connected to the high voltage output of the power supply. It may be found better to connect it to one of the lower voltage taps. The best one will depend on the plate current drawn by the receiver, and it should be the tap through

unit. If so, it is only necessary to install standard outlet receptacles on the exterior of the amplifier case and supply these through the main switch. If an a. c. receiver is employed and a phonograph is also used, it will still be necessary to incorporate a switch (a. c. type) as indicated at JSW-2, in order that the receiver may be turned off when the phonograph is in use, thus avoiding undue wear on the receiver tubes.

This amplifier, when set up and put into use, should provide extremely satisfactory results. The tone quality will be exceptionally good and everything about the unit is calculated to provide a happy combination of truthful reproduction, freedom from breakdown, and flexibility of service. Simplicity of operation is another outstanding feature that will be ap-

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preciated by anyone for whom such an amplifier is installed. For readers who may desire to build higher power amplifiers, the foregoing descriptive matter will be most helpful because many of the ideas featured in the present amplifier may be successfully incorporated in others.

* * * * *

In the subsequent articles of this series descriptions of typical installations will be given, together with illustrations and diagrams. These descriptions will be of exceptional value to installation men, and to men entering this new field, because many of the technical problems encountered will be discussed—such, for instance, as the proper connections where several loud speakers are to operate from a single amplifier, types and methods of installation wiring, methods of volume control, etc.

LIST OF PARTS

- 5 Yaxley Pup jacks, No. 416—3, 4, 5, 6, 7.
- 2 Carter Imp short jack switches, No. 66—JSW1, JSW2.
- 1 Electrad Super Tonatrol (constant) type U—R4.
- 1 Electrad Truvolt, T10—R2.

- 1 Electrad Truvolt, T20—R3.
- 1 Electrad Truvolt, T500—R5.
- 2 Carter Short jacks closed circuit, No. 2A—J1, J2.
- 1 Carter "Tu Way" telephone jacks.
- 1 Weston Milliammeter, 0-100 MA, type 301—M.
- 1 Amertran DeLuxe first stage audio transformer—T1.
- 1 Amertran DeLuxe second stage audio transformer—T2.
- 1 Amertram output transformer, type 200—T3.
- 1 Amertran Equalizer transformer, No. 389—T4.
- 1 Amertran output transformer, type 200—T3.
- 8 Acme parvolt by-pass condensers, 1 mfd. 200 volt—C1, C2, C6, C7, C8, C9, C10, C12.
- 1 Acme Parvolt by-pass condenser, 4 mfd. 200 volt—C11.
- 2 Benjamin sockets, No. 9040.
- 1 Benjamin socket, No. 9036.

- 1 Roll Acme flexible twisted filament wire.
- 2 Rolls Acme 16-30 flexible Celastite 6-32" nuts and screws.
- 1 227 type tube—V1.
- 1 250 type tube—V2.
- 1 281 type tube—V3.
- 19 ft. Angle Iron, 1/2"x1/2".
- 2 Sheets Iron, 3-32"x18"x10".
- Wire netting, 18" wide x 7 ft, 1/4" mesh
- 1 Panel Bakelite, 7"x18".
- 1 Amertran power transformer, type P. F. 281—T5.
- 1 Electrad voltage divider, type 250 ("C Bias" resistor not used)—R1.
- 3 Acme Parvolt filter condensers, 2 mfd. 1000 volt—C3, C4, C5.
- 2 Amertran chokes, type 709 L1, L2.
- 1 4 Point line switch—2.
- 1 Carter Imp power switch, No. 110-1.
- 1 2-way porcelain receptacle block.
- 1 length lamp cord with plug.

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Building A 245 Power Amplifier

(Continued from page 315)

off the current to the receiver entirely.

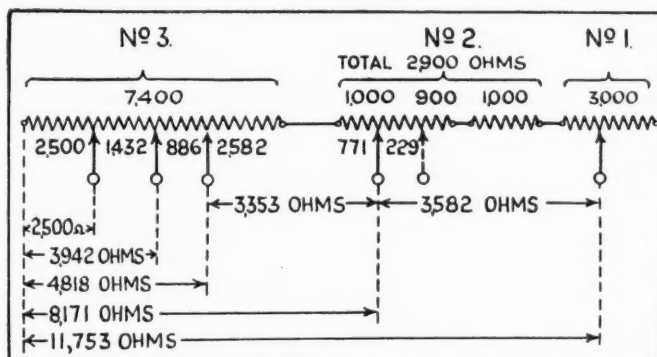
Connections of one unit to another within the console cabinet should be made by means of cabled leads, bunched together and bound with cord. Here, it is advisable to employ a color wiring so that in the case of error in connection, it will be easy to trace the wiring from one point to another.

It will be noted in Fig. 2 that an intermediate terminal board has been provided

agreeable hum in the loud speaker.

The design of the audio amplifier power supply device and the layout of the installation described here is offered to those desiring a suitable power supply unit housed, together with the tuner unit, in an acceptable type of console cabinet. Where the console to be used differs materially from the one illustrated, it will, of course, be up to the ingenuity of the constructor to arrange the location of the various units, so that not only will desirable, satisfactory results be obtained, but also a pleasing workmanlike appearance of the entire installation result.

Fig. 6. The Carter Resistor Kit No. 2314, consisting of three units, has its taps rearranged according to the circuit sketch shown at the right



between the radio tuner unit and the audio amplifier-power supply so that connection of the plate voltage leads from the power supply to the tuner unit may be made first to the intermediate terminal board. This terminal board is employed so that if it is desired to change either the tuner or amplifier, this may be done without disturbing the connections to the other. A similar terminal board may be employed, if it is desired, to connect the leads from the jack switch, SJ, to the audio amplifier. Thus, any one of the units may be removed at will, without disturbing the remaining connections to the other unit.

It is well to remember that the 110 volt supply cord to the power transformer and to the filament transformer and phonograph motor should be placed in the cabinet so as not to be near the tuner unit. Otherwise a disagreeable hum will be picked up from the line and amplified accordingly, producing the most dis-

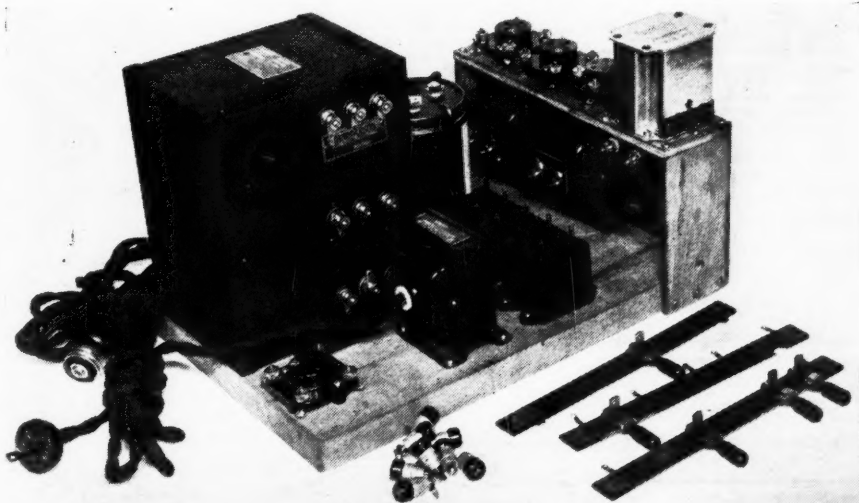
Audio Amplifier—Power Supply Parts List

AUDIO AMPLIFIER:

- One Thordarson audio transformer, type R400, T1.
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- One Thordarson output push-pull transformer, type 2903, T3.
- One Amertran equalizer transformer, No. 389, T4.
- One Benjamin five-prong a. c. socket, No. 9036, V1.
- Two Benjamin red top sockets, No. 9040, V2, V3.

(Continued on page 383)

A partly assembled view of the amplifier power supply device



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(Continued from page 381)

- One Carter wire-wound grid resistor, type DH-1500, 1500 ohms, R6.
- One Carter wire-wound grid resistor, type P-5-800, 800 ohms, R7.
- One Carter center-tapped resistor, type CE-6, 6 ohms.
- One Aerovox by-pass condenser, C1, 1 mfd.
- One shelf with end pieces (as described).
- One box Corwico Stranded Braidite.

POWER SUPPLY:

- One Thordarson 245 power compact, type R245, T5.
- One Mershon condenser bank, type T8, C2.
- One Carter resistor kit, No. 2314, R1 to R5.
- Four Aerovox by-pass condensers, 1 mfd., C3 to C6.
- One Benjamin red top socket, No. 9040, V4.
- One Thordarson filament transformer, No. 3660, T6.
- One Panel, 7" x 9" (for voltage divider).
- One Baseboard, 1" x 9" x 13½"
- Two boxes Corwico Stranded Braidite.

MISCELLANEOUS:

- One Electrad super-tonatrol, type U (phonograph volume control).
- One Yaxley DP-DT jack switch, No. 60, SJ.
- Eight Yaxley pup jacks, No. 416 (for L. S. and terminal board).
- Two Boxes colored stranded Corwico Braidite.
- Bakelite strip for terminal board.

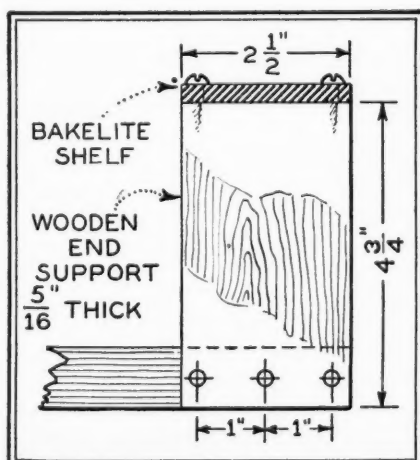


Fig. 5. Make two end pieces for supporting the shelf as shown here

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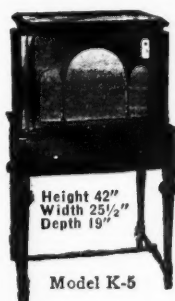
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